BOSTON, SEPTEMBER 1, 1878.

DEAR SIR: —

As the Author of this book is connected with our house, any further information which you may wish on any subject contained in the work will be cheerfully furnished upon receipt of inquiry; and we respectfully solicit a share of your patronage for Dyestuffs, Chemicals, etc.

After a careful perusal of this work you will kindly favor the Author by sending your **WRITTEN OPINION** in regard to it.

Very truly yours,

F. WOODMAN & CO.,
Sole Agents.

No. 44 KILBY STREET,
BOSTON.

THE AMERICAN DYER,

(ENLARGED AND REVISED):

A PRACTICAL TREATISE ON THE

COLORING OF WOOL, COTTON, YARN AND CLOTH,

ALSO, CALICO-PRINTING, ETC.

GIVING A DESCRIPTIVE ACCOUNT OF THE DYESTUFFS, THEIR ORIGIN, WHERE PRODUCED, HOW CULTIVATED, AND HOW PREPARED FOR USE, THEIR CHEMICAL COMPOSITIONS, GENERAL ADAPTABILITY, HOW THEY ARE ADULTERATED, ETC.

IT EMBRACES RECIPES FOR COLORING RAW COTTON TO BE MIXED WITH WOOL, FOR THE MANUFACTURE OF ALL KINDS OF FABRICS; RECIPES FOR COLORING WOOL, WOOLEN GOODS, COTTON AND WOOL GOODS IN THE PIECE, COTTON YARN (WITH SAMPLES), COTTON THREAD, AND WOOLEN YARN;

CONTAINING SEVENTY SAMPLES OF WOOL, COTTON YARN, AND CLOTH; SAMPLE OF BLACK ON RAW COTTON, COLORED AT ONE OPERATION;

EMBRACING, IN ALL, OVER FOUR HUNDRED RECIPES.

By RICHARD H. GIBSON,
PRACTICAL DYER AND CHEMIST.

BOSTON:
ALBERT J. WRIGHT, PRINTER, 79 MILK STREET
(CORNER OF FEDERAL).
1878.

INTRODUCTION TO THE FIRST EDITION.

In publishing this book, I have no doubt but there will be some dyers who will stigmatize me as an unprincipled scoundrel, for giving to the trade at large what they call the *secrets* of the trade. I will say to such, that the time has gone by when every one who was engaged in the art of dyeing, thought it was his imperative duty to keep everything connected with his trade a *secret*. This was an idea that universally prevailed among dyers. Within a few years, however, those connected with the pursuit of this branch of industry find that it is for their interest to make themselves familiar with every one engaged in the same pursuit, and to freely converse and exchange opinions upon those subjects in which they are most interested.

This familiarity among dyers has called forth other means of supplying the demand for information, so as to enable those not directly located in manufacturing centres to keep pace with the improvements and new methods of dyeing; and to supply this demand for information, books and papers are printed, which are freely read and well supported.

But among the many volumes of books on dyeing in circulation, there are at present none that can be called complete, as they merely give a recipe for a few pounds of wool or cotton, instead of a kettle-full, or the usual amount of wool colored at a time in all dye-houses, so that a person performing the operation, if not well acquainted (or a skilful dyer) with the quality and amount of the coloring matter contained in the drugs and dyestuffs they have to use, cannot use them economically, and, in most cases, cannot produce the color or shade desired.

In this work I have endeavored to give all the necessary information as to the coloring principles, their derivation, their adaptability and proper application, and it is, strictly speaking, a practical work upon the art of dyeing. If there are any dyers who wish to obtain more extended information, or fuller explanations upon the dyestuffs, than what is found in this book, they should consult such works as those of Berzelius, Bancroft, Berthollet, Chevrueil, Thomson, Napier, and others, which will repay them well for the time expended in perusing them.

The reader, in perusing this book, will find some quotations from the above-named eminent chemists, as well as from my father's works.

To these eminent men dyers are greatly indebted; they have given us a correct explanation of the chemical changes that take place in the different processes of dyeing; their skilful and laborous investigations have been very beneficial to dyers, in pointing out to them the necessity of a chemical knowledge of the first principles of the art of making artificial color, or dyeing; for, if there is one art more than another that requires such a knowledge, it is the art of dyeing, for it is of the utmost importance for a dyer to understand chemistry, at least that part of it that is connected with his trade; for without this chemical knowledge, dyeing cannot be either profitably or economically followed, as it depends entirely upon chemistry for its full development and successful practice.

I have not written this book with the expectation that every one who will purchase it, and who understands the manual of operations in a dye-house, can be made a skilful dyer by the perusal of it, and every intelligent dyer will exonerate me from harboring such an idea.

RICHARD H. GIBSON.

PREFACE TO THE SECOND EDITION.

In offering this my second work on the art of dyeing to my brother dyers and others, it becomes necessary that I make a few preliminary observations. In the first place, this work is, in one sense of the word, a revision and enlargement of my former work. As the author, I claim to have no more scientific knowledge than just the "*quantum sufficit*" for the successful practice of the subject upon which I write, and which has engaged my strict attention and earnest study for over twenty years; and the trade of a dyer has been followed, under similar circumstances, by my family, in direct *succession*, for nearly two centuries. Therefore I am a dyer simply by necessity, as it were, and having received but a common English education, and acquired enough chemical knowledge to qualify me for the situation in life which I have thus far filled, nothing more, therefore, must or should be expected from my pen, by men of science, than merely to call their attention to the investigation of an art that will repay their trouble by the pleasure they will derive from observing these beautiful and delicate chemical changes which take place in the different operations of dyeing, or the producing of artificial colors.

To men of science, no new and brilliant discoveries are announced, to create astonishment; neither, in these pages, is there any strange theory brought up, to call out the mind in subtle controversy; no, very little indeed is offered the reader, more than the plain description of a business that has engaged the attention and experience of the writer.

For the above reason, therefore, this work should not be criticised as emanating from the brain of a learned philoso-

pher, but should be viewed as the labor of an uneducated dyer, and intended for the perusal and inspection of men of the same pursuits and acquirements as himself.

All the recipes, processes, &c., described and embodied in this work, are such as the writer can with confidence recommend, having practised successfully with them; and should recipes be given not my own, or those which I have not worked by, they will be credited to those persons from whom I received them.

In the description of the various coloring materials, if derived from the animal, vegetable, or mineral kingdom, the attention of the author has been directed to their natural history, the place of their growth or production, the methods employed in collecting and preparing them for the market and use of the dyer, their commercial history, the state in which they reach us, their properties, their chemical composition and relations, the changes which they undergo by time and exposure, their accidental or fraudulent adulterations, their coloring properties and applications, their economical use, &c., &c.

The coloring substances or materials which are obtained from the mineral and animal kingdoms, and those furnished by the chemical manufacturer, are of a nature to admit of no general precepts as to their proper condition, which would not be suggested by the common sense of the dyer and purchaser. He must receive them as offered, and judge of their fitness for his purposes by his knowledge of the peculiar properties of each.

The author may perhaps be permitted to observe, in relation to himself, that he has expended much time and labor in the revising of this work, and has sought diligently for facts from almost every readily accessible source. He has endeavored, by a comparison of different authorities, to ascertain the correct theory or facts, whenever it was practicable. He is conscious, nevertheless, that, in the multiplicity of details, very many errors and deficiencies may exist, and that the

faults of undue brevity in some cases and great length in others may not have been entirely avoided; but he ventures to hope that the skilful and candid dyer will make all due allowances.

A full and carefully prepared index is added, also a glossary of technical terms and chemical nomenclature, together with the chemical formulas of the different salts, acids, &c., mentioned in the work.

The author acknowledges his great obligations and indebtedness to Professor John Peirce, William Hunter and others for the valuable assistance and information rendered him in regard to the subject of calico-printing; he is also greatly indebted to Dr. T. P. Shepard, who has kindly consented to allow the insertion in this work of his "Recipes for Calico-Printing."

The student and dyer, in perusing this work, ought to read it in a regular course. By so doing he will be enabled to understand the manner in which the recipes are to be manipulated. He should peruse more particularly the *remarks* upon the *recipes* for the different kinds of goods or fabrics for the coloring of which they are written.

Citations of different authors have been but partially made in this work. The writer, for the purpose of giving his sources of information, and for the convenience of those who wish to pursue the different subjects further, refers them to such works as Bancroft's Philosophy of Permanent Colors, Edinburgh Encyclopædia, Berzelius, Chevrueil, Persaz, Lectures of Dr. Grace Calvert, Chemical News for 1872, O'Neil's Dictionary of Dyeing and Printing, Muspratt's Chemistry Applied to the Arts, Napier's Chemistry Applied to Dyeing, Ure's Dictionary of Manufactures, edition of 1860.

RICHARD H. GIBSON.

44 Kilby St., Boston.

Part First.

DYEING AND MORDANTS.

DYEING AND MORDANTS.

THE object of the dyer is to impart to wool, silk, cotton, and flax, either in their loose or raw state, or in their woven tissue, some color or other, and dyeing is the art of impregnating these substances with coloring substances which are more or less permanent. The colors themselves are not material; they are merely the impression of light upon the eye, and the result of the abstraction of the hues from the solar beams, by the affinity which the coloring matter has for those hues; and the coloring matter coming in contact with metallic oxides, the different hues or colors are fully developed and shown to the human eye, as they are from a prism; and all the colors, whether they are artificial or natural, or on whatever seen, have once been beams of light in the heavens; therefore, dyeing is the fixing of substances upon fabrics, which will act upon light in a different manner from the substances themselves. As every chemical change affects the character of the substance in its relation to light, the dyer's object is to cause a combination with the wool or other textile fabrics, that will produce certain effects upon light, and thereby produce different colors or shades; and as a color consists of parts or substances only, and combining these substances or materials in the best manner and fastening it permanently upon different fabrics, and with a knowledge of the chemical laws on which these effects are based or founded, is what constitutes the skill of the dyer. Dyeing is distinguished from painting by the fact that the colors (or pigments) are fixed to the animal and vegetable textile fibres according to certain physico-chemical principles; but it is not so in painting, as painting is simply fixed by adhesion to the

surface, although painters and dyers occasionally use the same pigments. So is printing of fabrics distinguished from dyeing, as it consists of duplicating of colored patterns, yet it is a very important part of dyeing. Dyeing, strictly speaking, means the coloring of absorbent substances by impregnating them with solutions of coloring matters. It is thus opposed to painting, which consists in laying a color upon the surface to be colored.

As animal charcoal and arable soil are possessed of the property to assimilate in their pores coloring matter and some inorganic substances without the latter being altered, so also do animal and vegetable fibres possess the property of absorbing from solutions and fixing in a more or less insoluble condition dyes and some of the constituents of mordants. This combination or union is often so loose that it is easily broken up by repeated washing in water, especially if washed in hot water. For instance, if a textile fibre is dyed (or rather tinged, for dyeing implies fixity) with sulphate of indigo, or with Berlin blue in solution with oxalic acid, the color imparted to the fibre will entirely disappear by repeated washing in water.

A fibre can only be dyed in the strict sense of the term when the dissolved coloring matter has been united in *insoluble* condition with the fibre, and for this purpose the intervention of a third substance is required; viz., a *mordant*. The union thus formed will resist the action of solvents; that is, it will resist repeated washings in warm water and soap, and the color thus produced is termed fast, and will resist the action of light, air, and weak alkaline solutions, also weak acids. A color which does not resist these agents is termed fugitive. Dyeing is based upon chemical principles, but as regards the fixing of the dye by the fibre, it would appear to be only a physical attraction, as there does not exist between a certain quantity of fibre and of dye an atomistic relation. Moreover, neither fibre nor dye have lost, after fixation has taken place, their characteristic properties. The insoluble

condition of the union between the fibre and the dye may be obtained in various ways; viz., by removal of the solvent, as, for instance, oxide of copper dissolved in ammonia may be fixed by simply evaporating the ammonia. Chromate of zinc dissolved in ammonia can be fixed in the same manner as the oxide of copper. The precipitation of carthamine ($C_{14}H_{16}O_{17}$) from its alkaline solution by the aid of an acid, and the precipitation of some of the tar colors from their alcoholic solutions, belong to the same category. The insoluble condition can be produced by oxidation (in calico-printing and cotton dyeing, called the ageing process) the previously soluble color being rendered insoluble by taking up oxygen.

If we should attempt to trace the origin and progress of the art of dyeing from its first beginnings, whether those beginnings were in the most remote antiquity, or in those stages of its reappearance in more recent ages, after this art, as well as most other useful ones, had experienced a partial, if not entire destruction by those civil and political convulsions which have frequently swept away all traces of civilization from our globe, save the ruins of some stately edifices, which, from their very magnitude, bade defiance to the power of the destroying generation to remove; — we say, should we attempt to trace its rise either from the ruins of overthrown arts, or endeavor to show what was its beginnings and greatest state of perfection in the earlier stages of the world, we should have a task of no common magnitude before us, for we should have to penetrate through the gloom and obscurity of past ages; we should have to plunge for our subject into that dark epoch of time when dyeing, as well as other useful arts, began, and long before the age in which they originated was sufficiently enlightened to produce an historian, or the times had afforded sufficient materials for history. Therefore, we will not attempt to give the exact data when it was first practised as an art; but historians speak of it as being practised in very early times in the East, and that it was as common to the most

primitive life as to the most advanced stages of civilization. Colored garments are mentioned in the earliest records. (See 37th chapter of Genesis, 23d verse.) The Orientals for ages have practised the art of dyeing. Notwithstanding the length of time the art has been practised, the most wonderful improvements have been made in the art within the last twenty years, and these improvements have not been the result of accident or chance, but are the work of chemists, and by those very chemists who are engaged in the solution of the highest as well as most abstruse problems. These illustrious chemists have distinguished themselves in the discovery of new dyeing substances or principles, which are rapidly taking the place of the old materials. There is no doubt in my mind that, in the earlier ages, the art of dyeing was brought to a greater degree of perfection than it is at the present time; and, for these reasons, that they were capable of carrying it to a much greater degree of perfection than we are, will be obvious to every reflecting mind. Their extreme longevity afforded to every individual engaged in it sufficient time to bring to maturity any intricate invention which requires so much study and time to perfect its parts as to make it the work of successive generations of our short-lived race to complete. For instance, such an invention as the steam-engine, which occupied two or three hundred years in progressing to its present state of perfection, would not have required the attention of one of these men a fourth part of their lifetime, and some antediluvian Watt would have completed this ultimatum of human skill long before his faculties had acquired their full strength; and an ancient Dumas or Berthollet might have done the same in perfecting the art of dyeing.

If the numerous coloring substances that we use in dyeing had an affinity for the wool or cotton in its natural state, dyeing would be a very simple process, and every one could be a dyer, for all that would be required would be to make a solution of the dyestuff, and dip the wool or cloth in it, and it is colored; but this we find is not the case. With the exception

of indigo, there is scarcely a dyestuff that will impart its own color to goods, that deserves the name of color. When the dyer ascertains that there is no affinity between the fibre he has to color, and the coloring substance he has to use to produce the desired color, he endeavors to find a third substance that will have a mutual attraction for both the fibre and coloring matter, so that by combining this third substance with the fibre, and passing it through the dyeing solution, the color combines with the substance which is upon the goods, and then constitutes the dye. This third substance used is called a mordant. The variety of mordants is almost infinite; they being as numerous as it is possible, for all the acids to form different combinations, in variable proportions, with all the alkalies, earths, and metals. "They are either neutral, sub, or super salts; that is, the acid and the base or radical, are either in proportion to mutually saturate each other, and form a neutral compound, or the base is not fully saturated with the acid, in which case it is a sub-salt; or the acid prevails over the base, when it is said to be super-saturated with it; it is then a super-salt. They are distinguished as the alkaline, earthy, or metallic salts, according as these respective substances form the base or radical of the salt." "Two or more of them are capable of uniting together, and also two bases can unite to one acid, or two acids to one base, forming compound, triple, &c., salts." All the mordants, with but one or two exceptions, are found among the metallic oxides. It might be supposed from this, that as metals are the most numerous class of elements, mordants should also be as numerous; but this is not so. In order that this third substance spoken of may act as a mordant, it is required to have certain properties; it must have an attraction for the coloring matter, so as to form with it an insoluble colored compound, and it must be held very easily in solution. It should also have an affinity for the fibre, a tendency to unite with it; but this property is not always essentially necessary, only the first two are so, and they limit the mordants almost wholly to what

are termed the insoluble bases; that is, substances which are not of themselves soluble in water. The principal and most essential part of coloring is a right choice and proper application of the various mordants; there being a chemical union between the mordant and coloring matter, a new substance is formed, differing not only in properties but in color from any of the originals; therefore, a very little alteration in the strength or quality of the mordant gives an alteration in the shade of the color.

Thus, by carefully studying the conditions of the mordants, and the relation they have to the coloring matter, the reactions which will take place under the varied circumstances of their application, and what kind of reaction will be required to obtain the results we want, the dyer will then find his trade not only easy but pleasant and most interesting. He will also find, that if the mind guides the hand, labor will not then be felt as a curse or a degradation. This right choice of the mordants to be used, and the alterations that the dyer can make in them, gives him a much wider field for a variety of shades, and, at the same time, a less number of coloring substances are required; as, for instance, we know that logwood alone gives no color to cotton which is worthy of the name of color, yet, by a judicious application of a few different kinds of mordants, we can obtain all the shades from a French white to a violet, from a lavender to a purple, from a blue to a lilac, and from a slate to a black. In regard to mordants, Dr. Bancroft, in his work on the Philosophy of Permanent Colors, arranges all colors in two classes; viz., *substantive* and *adjective*. By the former is understood those which, without the aid of a mordant, become fixed upon the textile fibres in an insoluble condition. By *adjective* colors is understood such as require an intermediate substance (a mordant, in fact), to become fixed upon the fibre in an insoluble condition. He says: "To me, coloring matters seem to fall naturally under two general classes. The first including those matters which, when put into a state of solution, may be fixed with all the

permanency of which they are susceptible, and made fully to exhibit their colors in or upon the dyed substance without the interposition of any earthy or metallic basis. The colors of the first class I shall call *substantive*, as denoting a thing solid, by or depending only on itself; and the colors of the second class I shall call *adjective*, as implying that their lustre and permanency are acquired by their being adjected upon a suitable basis."

"Earthy and metallic substances, when thus interposed, serve not only as a bond of union between the coloring matter and the dyed substance, but they also *modify* as well as fix the color; some of them, particularly the oxide of iron, and the earth of alum, *exalting* and *giving lustre* to most of the coloring matters with which they are united; whilst others, and especially the oxide of iron, blacken some, and darken almost all such matters, if made to combine with them."—*Bancroft on Dyeing, Vol. 1, p. 118.*

Mordants modify the original color that a dyeing material yields; for instance, with alumina mordants, madder will yield pink, red, and scarlet, and with the salts of iron, according to the degree of concentration, madder yields lilac, purple, black, and, with certain salts of copper, madder will yield a brown.

The theory of the action of mordants is connected in the closest manner with that of dyeing. It may, in fact, be viewed under two different aspects. Often there exists a true combination between the material to be colored, and the coloring matter,—a combination which is only determined by a veritable affinity between the coloring matter and the material colored, and which presents a condition that is analogous to that which occurs in all chemical combinations; that is, a state of saturation, beyond which the union of these bodies becomes of a very unstable character. At other times, on the contrary, we regard the coloring of wool, silk, and cotton, as produced by a mechanical phenomenon, by virtue of which the coloring matters will become fixed or confined

in the meshes of organic filaments contained in the material to be colored. "It approximates the theory of dyeing to some analogous phenomena which we find manifested by animal charcoal on colored solutions; for as the animal charcoal seizes upon the coloring matters contained in an aqueous solution, and renders them insoluble by fixing them in a purely mechanical manner within its own pores, so may the wool, the silk, and the cotton appropriate the coloring matters held in solution, and, by fixing them in their pores, render them more or less insoluble to water." The experience of dyers has taught them that dyeing thus produced is always lacking both in permanency and intensity, — two properties which we obtain if we previously mordant the material before attempting to color it. It can be easily seen that the mordants can be fixed in the tissues of the material by similar causes to those which determine the fixation of the coloring matters by animal charcoal. Mordants that are insoluble of themselves have to be dissolved in some suitable menstrua before their particles can combine with the coloring matter, or even enter into the fibres of the goods. The dyer must attend to the degree of affinity between the mordant and its solvent, in order to determine what force the solvent will exert against the mordant combining with the fibres of the cloth, should there exist an affinity between them. Otherwise a powerful mordant can be weakened by the attraction of its solvent; for instance, *common alum*, at its greatest concentration, is a very feeble mordant for cotton, owing to the great attraction between the alumina and sulphuric acid. Alum is, however, a powerful mordant for wool or woolen fabrics, and is generally used along with tartar, and often with the tin solutions. The mordants employed for calico-printing are chiefly such salts as are comparatively loose combinations of acid and base, so that the latter can easily unite with the fibre; and among the mordants chiefly used, the acetate of alumina and iron occupy the first place, while alum, as a solution of aluminate of soda, is now more rarely used.

The mordant, or, more properly speaking, the solvent of the base constituting the mordant, should not be capable of injuring or destroying immediately, or by prolonged action, either the coloring matter or fabric. Acids, of themselves, do not serve as mordants, as they would destroy the coloring or the fabric; but in cases where destructive acids have to be used, they must be immediately washed off the fabric in order to neutralize the acid before it has time to act upon the color or tissue. The action of bases upon colors, and the composition of those best fitted or adapted to give permanency and beauty, are a very important part of dyeing, and should be thoroughly studied and understood by all those who intend to follow the art of dyeing as a profession, and expect to become proficient in the trade. We will not attempt to discuss whether such substances as nutgalls, sumac, tannin, or catechu, can really be termed mordants; but we find that these substances, in cotton dyeing, are very essential for fixing within the fibre of the cotton such quantities of the metallic base or mordant as are required to give depth and permanence to the color; but as these astringent substances are known to produce tints with the bases, they, like mordants, affords us a wider field for variety of color. Sumac, nutgalls, and catechu, or cutch, are very extensively used in cotton dyeing and printing, in connection with the metallic bases, to fix, modify, and to give depth of colors, for which these bases are applied. The mordants generally used for silk and wool, do not act the part of mordants for cotton.

The following theory of actions of mordants, is condensed from the "Pharmaceutical Times," vol. 2, p. 63, which says that "cream of tartar, or bitartrate of potash, constitutes, of itself, a very feeble mordant, but which is very often used for dyeing wool or woolen goods, when the dyer wishes to give a delicate and brilliant shade. It is usually used along with alum, the tin solutions, and sometimes with sulphate of iron (copperas). Its influence, under these circumstances, consists in determining a double decomposition, from which

is produced a sulphate of potash ($KOSO_3$), or chloride of potassium ($K\,Cl$), whilst the tartaric acid ($C_4H_2O_5$) combines with the alumina (Al_2O_3), the peroxide of iron (Fe_2O_3), or the oxide of tin ($Sn\,O_2$). Now it is very probable that the coloring matters remove the alumina, the oxide of tin, or peroxide of iron, more readily from tartaric acid than from sulphuric acid (SO_3). Moreover, the presence of free sulphuric acid would certainly prove injurious, as well to the wool, as to the coloring matter, whilst free tartaric acid can exercise no unfavorable action over them.

"The subjecting of the wool to an alum mordant, is always done at a boil; the mixture used in this process, is a compound of alum and cream of tartar. One of the objects of this addition is to free the bath of the carbonate of lime ($Ca\,CO_3$), which most all waters contain in solution, and which, acting upon the alum, would partly decompose it, by producing an insoluble subsulphate of alumina and potash; this, accumulating upon the wool, and, becoming unevenly fixed upon the surface, would leave clouds or blotches upon the wool when it was taken out of the dyeing bath or tub.

"But independent of this effect, which might be produced by an acid, cream of tartar appears to be capable of effecting a farther object, by inducing a double decomposition, which transforms the alum into a tartrate of alumina.

"Wool, or woolen cloth, when dipped in a cold solution of alum, appropriates a part of the alum to itself, and yet there is not seen any alteration in the wool; but if the wool or cloth is boiled in an alum solution, it yields to this liquid a portion of its organic matter, which becomes dissolved; but, at the same time, the wool absorbs an equal amount of the alum.

"We have only to show the action which the wool undergoes, when brought in contact with alum and cream of tartar, at one and the same time. It is very possible that there may be, in this case, a simultaneous fixation of alum, as well as of the double tartrate of alumina and potash, and of tartaric

acid. The presence of alum in the wool or cloth, when taken out of the boiling solution, is very evident; but the presence of tartrate of alumina and potash, and of free tartaric acid, is only presumable.

"Silk, in the like manner, unites itself with alum when placed in a cold solution of alum, and afterwards parts with it to boiling water; it may be reproduced from this liquor by evaporation. The action of silk on acetate of alumina ($2Al_2O_3+3C_4H_3O_3$) is identical with wool. It, at first, absorbs the alum in its pure form, then, by desiccation, it loses some acetic acid ($C_4H_3O_3$), and retains a mixture of the acetate, together with alumina in its free state; it gives up a farther portion of this acetate to boiling water.

"The alum mordant is always used cold for silk; if used hot, it would destroy the lustre of the silk; neither should the bath contain tartar when used for silk. There will, therefore, be no difficulty in imagining that silk, wool, and cotton, may, in their character as porous bodies, purely and simply seize upon the alum, and that the alum, when once impregnated in the pores of the silk, wool, or cotton, may afterwards react upon the coloring matter according as the alum, in its turn, penetrates the interior of the silk, wool, or cotton.

"It is certain that silk, wool, and cotton, possess, in a high degree, the faculty of seizing upon the insoluble coloring matters when these are presented to them in their nascent state. We find that cotton is dyed a rose color in a solution that contains carthamic acid in suspension, arising from the decomposition of carthamate of soda by an acid. In the same manner, we find wool will acquire a dark slate color by being immersed in a solution of copperas and tannin, by attracting to itself the black precipitate which results from mixture of the iron salt and tannin. Consequently, although the dyer endeavors to produce the insoluble compound, on which the coloring of the material depends, within the very pores of the tissue, still we may affirm that, in many cases,

the cloth or other material, when placed in presence of the nascent precipitate, has the property of seizing upon it, and thus acquiring a shade of greater or less intensity.

Dumas says: " This property is due to some undetermined and yet unknown cause, and must undoubtedly be referred to the reaction that takes place between the alum and the soluble coloring matters, as well as to some other mysterious phenomena which take place in dyeing. If not, how are we to account for the wool so easily and readily assuming a scarlet color, while in silk and cotton we are unable to fix the proper scarlet color? Or how can we understand why certain colors should become more permanently fixed on certain kinds of materials than on others, unless it is by virtue of some special action, designated by the name of affinity, but which does not the less constitute a force, or rather a consequence of diverse forces of which we must take full account during the different manipulations of dyeing."

To confound, in fact, a chemical affinity, so called, such as is evidenced in ordinary chemical combinations, when produced in definite proportions, with the phenomena of dyeing, is to mix together two very distinct ideas. For instance, we find the union of wool with indigo, and silk with Prussian blue, quite a different operation to the combination of lead with sulphur. But if we should consider the material to be colored as a simple filter and to be capable of retaining in its pores certain precipitates, and of receiving from these precipitates a certain color or colors, we should go equally as far in the opposite direction. Neither would this supposition explain the manner in which a colored lac is formed in a greater part of the operations of dyeing, operations which are effected by an alum or an aluminous salt and a coloring solution, altogether incapable of producing any lac, except by adding an alkali for the purpose of setting at liberty the alumina, or of a material which has the power of taking up that lac as soon as it shall be formed.

The experiments of Chevrueil show us that the material and

the color, when they are once united, will form products that are possessed of properties which differ according to the nature of the material even in the same given color. Therefore, the properties of the coloring matter are modified by the peculiar action of the wool or fabric on the dye. There are very many examples that place this assertion beyond all cavil. It is very necessary that the mordants should have a prime equivalent to the coloring matter, and that the doctrine of prime equivalents be brought into practical operation in the art of dyeing; for as the dyestuffs and mordants do naturally combine in determinate and definite quantities only, we should, in forming colors, take merely that just proportion or prime equivalent of each of the constituents necessary to form that definite combination, as an excess of either of them is a loss in the materials or an injury to the fabric or color.

What these combining proportions are in every case we have yet to learn by a series of well-conducted experiments. A table or tables of the prime equivalents of the different chemical salts to that of the different coloring materials would be of the greatest importance to the economy and successful operations in dyeing.

It is only by an attentive and systematic study of the specific properties of the mordants and coloring matters in their relation to each other that we can hope to direct the future progress of dyeing to its ultimate perfection; for it is only the nicest arrangement of chemical laws that enables the dyer to turn to his advantage the different coloring matters he may be in possession of, and we find that the art of dyeing is wholly dependent upon chemistry for its full development and successful practice; and this being the fact, no person should attempt the practice of dyeing without first being conversant with chemistry, at least that particular branch of chemistry that is in connection with or is applied to the art of dyeing or making artificial colors, if he expects to make a skilful dyer or meet with successful results for himself or employer.

"Sometimes there are circumstances or powers occurring in the operations of dyeing which interfere with or direct chemical affinity in the particles of bodies, so that one body often induces a chemical change in another body and at the same time will not undergo any change itself.

"This power or affinity is termed *catalysis*, and a good instance of this power or affinity we find in fermentation. For instance, if we put a little yeast in beer to induce fermentation in all the solution, we will find that the yeast remains unaltered; or if we boil starch with weak or diluted sulphuric acid, the starch will be first changed into gum and afterwards into sugar; but, notwithstanding the above-named changes, we find the sulphuric acid is unaltered, either in quantity or property.

"There are a large number of substances which possess this property of *catalytic* influence; and, if so, it is not unlikely that such fibrous materials as woolen, silk, and cotton should possess it towards some of the vegetable coloring substances used in dyeing. Many of the operations in the dye-house show to us the presence of some such power, but the nature of this power is not yet fully understood."

The force of affinity is largely influenced by the conditions in which the bodies we wish to combine are placed. Solid bodies generally have no chemical action one upon the other; for which reason it is necessary that they be brought into the liquid state before any chemical change can take place. This is necessary in all the operations of dyeing, not only to cause combination, but to allow the particles to penetrate the fibre of the material we wish to operate upon, and while there, to be operated upon by the affinity of another body, also in solution, brought into contact with them. This is a very essential condition of all dyestuffs, and of all salts we wish to use in dyeing, either as mordants or dyes, and this should never be lost sight of when studying either the philosophy or practical operations of dyeing; for if there is anything that interferes with the free operation of these conditions, or rather

solubility, it will hinder or put back the process or else injure the dyeing solution.

"We will here mention, that the introduction of the term *catalysis* was only considered useful as bringing into one class or group a certain class of phenomena; but the same might be said of the useful term *affinity*. But when our knowledge of these powers, which are hidden, is more advanced, perhaps then all these phenomena can be accounted for, and arranged under the operation of some one universal power or law."

In the first part of this article we alluded to the antiquity of the art of dyeing; yet notwithstanding its antiquity, there have been made some of the most wonderful improvements in the art within the last twenty years, by which the old processes have been completely revolutionized. And these improvements are due to the patience and profound investigations of chemists, and not by chance or accident, but by those chemists who are engaged in solving some of the highest and most abstruse problems.

Among these illustrious chemists are such names as Hoffmann, Nicholson, Poirrier, and others, and although none of the above-named eminent men are practical dyers, yet by their profound and scientific investigations dyeing has been elevated to its proper rank as an art; and to them and other illustrious and scientific men, are dyers, and even the world at large, indebted, for by their profound and laborious investigations of the different processes of dyeing, and their correct elaborate analysis of the materials used, and by identifying and connecting its principles with chemical science and knowledge, they have brought the art into notice as connected closely with chemistry, and given it a pre-eminence as one of those arts which are dependent upon chemistry and chemical knowledge for its economical and successful practice. They have given us useful and minute descriptions of the materials we as dyers have to make use of. They have given us clear and correct explanations of all those chemical changes which take place in many of the different processes

of dyeing, and have given us satisfactory accounts of some of the most complicated and inexplicable combinations which often occur in dyeing. They have more especially distinguished themselves by their discoveries of new dyeing or coloring materials which are fast taking the place of the old materials.

THE NATURE OF COLORS.

"Strictly speaking, colors have no existence, but are the effects of light; or, at least, colors do not exist in the objects that appear to be colored, but in the light which is reflected from the apparently colored object.

"To define color we will briefly state what is known upon the nature and composition of light.

"A beam of light is composed of three distinct colored rays: red, blue, and yellow. When a beam strikes the surface of a body it bounds off as an elastic ball would do in striking the same surface, and this bounding off is called *reflection;* or it is absorbed by the body and disappears and is altogether extinguished, or it passes through the body, making it transparent."

"The bounding or reflecting rays pass into the eye, and the article or substance from which it is reflected appears white or some particular color. No light can proceed from the object to the eye, it being absorbed and extinguished, the body therefore will be invisible; or, if the surrounding objects reflect light the article or substance appears black, but if the light passes through unaltered it will appear clear. Thus what it is custom to call white light is the simultaneous transmission of three colored rays." "For instance, if you admit light into a dark room through a small hole in a window-shutter, and a glass prism is placed in the hole, and opposite to it, on the wall of the room, place a piece of white

paper, so that the light passing through the hole will strike upon the paper, you will see that the light is decomposed and will appear upon the paper in the following order:

Violet,	Green,	Orange,
Indigo,	Yellow,*	Red,*
	Blue.*	

"These are called the seven prismatic colors; those that are marked thus * are the simple or primary colors; that is, they require no admixture to produce them, but the others do; the orange is a mixture of red and yellow, the green requires a blue and yellow, the indigo requires the admixture of the blue and red; the same with the violet. The prism through which the light passed into the room, from its shape, effects a complete disturbance of the light, which causes the different colors to be seen on the paper. Similar disturbances and effects are produced when light is reflected from a surface. The different combinations of the red, yellow, and blue which produce the various shades of color, are produced according to the rate of the disturbing influence upon the different rays of light. And as every chemical change affects the character of the substance in its relation to light, the dyer's object is to cause a combination with the wool, silk, cotton, and other textile fabrics that will produce certain effects upon light, and thereby produce different colors or shades. The following very simple experiment will illustrate how great is the production of colors dependent upon their relation to the substance of light.

"Take a solution of iodide of potassium (KI), which is colorless and transparent, and divide it into three equal parts; into one proportion pour a little sugar of lead ($Pb\ O, C_4H_3O_3$), into the other a persalt of mercury ($Hg\ Cl_2 =$ corrosive sublimate), and into the third a little starch, with a few drops of nitric acid (NO_5). These are all colorless substances (when in solution by themselves), but after mixing

them we will have in the first a deep and beautiful yellow color; in the second, a red; and in the third, a blue."

Thus we see that the three primary colors can be produced with the same substance when it is combined with other substances, which were, previous to the combination, colorless. And although this experiment, and the remarks made preceding it, go to prove that color has no material existence in the substance which appears to be colored, the question is still one of chemical action.

A chemical compound alone can be produced that will vie with nature in the brilliancy and beauty of its shade; yet, if that is produced within the fibre of the wool, silk, or cotton, the light will have to be transmitted through the wool, silk, or cotton, as a medium, and the fibre of these substances not being transparent, we find that the original beauty of the color will be greatly diminished. For which reason the same color, if fixed within the fibre of those three materials, will have a different appearance in each of them. These circumstances, when viewed in all their relative positions, will afford the dyer subjects for constant study and experiments. We cannot follow nature in its production of colors; for should the dyer try to produce a *white* by mixing the red, yellow, and blue in exact proportions, he would obtain a black instead of a white. But the producing of white by the combining of the three primary colors, is an every-day occurrence with the practical bleacher. No matter what the process for bleaching the goods has been, they will come out of the bleach having always a brownish-yellow tinge to them; and if the goods are cotton, a little indigo blue is added, and the result is a purer white. If the goods are silk, they will have a much more yellow tinge than there is on cotton, and to get rid of this yellow tinge on silk, the bleacher adds a little Prussian blue and cochineal, or what is most commonly used is archil, which gives a violet color. The amount of these materials used will vary according to the depth of yellow on the silk, the result being a very beautiful white.

By the preceding observations we come to the conclusion that color is the result of the abstraction of the celestial hues from the solar beams by the affinity of the coloring matter for it, and the coloring matter coming in contact with metallic oxides, the different hues or colors are fully developed and shown to the human eye as they are from a prism; and all the colors, whether they are natural or artificial, or on whatever seen, have once been beams of light in the heavens, and the impregnation of the coloring matter with a ray of light, and then being by it transferred to an oxide, which then reflects upon the eye, constitutes the whole philosophy of colors; and the dyer, when engaged in his profession, is performing the operation of transfusing celestial hues through terrestrial substances. He is imbuing material substance with the immateriality of light.

"Color consists of parts and substances only, and combining these substances or materials in the best manner, and then fastening them permanently upon the different fabrics, and with a knowledge of the chemicals on which these effects are based or founded, is what constitutes the skill of the dyer."

THE PROPERTIES OF COLORS, AND THEIR RELATION TO THE ART OF DYEING.

FROM GIBSON'S SYSTEM AND SCIENCE OF COLORS.

"The cause of dyestuffs giving a color with metallic or earthy salts, is owing to a peculiar principle which they contain; that is, a crystallized body, when pure, having a greater affinity for metals and earths than it has for any other substance, precipitating them when held in solution by either acids or alkalies, and producing compounds or lakes of but slight solubility, which have a natural tendency to enter into

combination with animal fibre, the force of whose combined attractions, water or other common agents are not capable of separating.

"To this precipitate we give the name of color; and the knowledge of making it, with the subsequent process of combining it with wool or manufactured fabrics, we designate as the art of dyeing or coloring.

"A color, therefore, is a chemical compound or colored salt; and coloring, or dyeing, is a chemical art.

"On mixing two clear solutions, one of coloring matter, and the other of a metallic or earthy salt, the substances that are held in solution pass immediately from the liquid to the solid state. In some cases this change is sudden and instantaneous, and the solid result falls rapidly to the bottom of the vessel as an insoluble powder. In other cases the mixed liquors gradually assume opaqueness; and soon a separation takes place, and a broken, curd-like matter slowly subsides to the bottom, and lies in a loose, flocky state, which the least agitation causes to rise into the supernatant liquor. It is slightly soluble. This passage from liquidity to solidity is the first effect perceived on the formation of color.

"The first of these transitions being perfectly insoluble, the aggregate possesses not the slightest tendency to unite with animal or vegetable fibre. Consequently, an insoluble color can never be chemically combined with any animal or vegetable matter at a single operation in dyeing, or applied as a topical color in calico-printing; and if it were attempted, the result would be a mere mechanical adhesion of the particles of color to the article to be colored, which mere washing in water would remove. This shows that dyeing is not a mechanical fixation of color, but a chemical combination of it with the substance to be colored.

"But as the component parts of this insoluble color have each, when separate, a strong inclination to combine with animal and vegetable tissues, and also with each other, the process of dyeing is effected by first impregnating the fabric

with the oxide of the salt used, and then passing it through a solution of the coloring matter.

"The perfectly insoluble colors are mostly mineral, and their specific gravities are much greater than those that are partially soluble, or whose color is obtained from the vegetable dyestuffs. The character of insolubility gives to a color the power of resisting decomposition by light, and the action of the atmosphere. The mineral colors possess this quality in a more eminent degree than such colors as are derived from vegetables.

"The most insoluble colors are therefore the most durable, and those which are extremely soluble are the most fugitive; and there is not an instance where a very soluble or liquid color is a permanent one. As a proof of this assertion, we will take the sulphate of indigo (chemic), which is soluble to an unlimited extent, but is remarkably fugitive; while the indigo from which it was prepared, is the most durable color afforded by the vegetable kingdom. There are other examples of this kind.

"We will return from this digression to the second or partially soluble kind of color, which are almost all those colors employed by woolen dyers; the vegetable dyestuffs not forming absolute insoluble compounds with the metals and earths, excepting in the case of indigo, and, perhaps, one or two more instances. This kind of color is that which forms the topical colors (see calico-printing), or the colors of application of the calico and woolen printer; or such as (all the materials of the color being mixed together) are then applied at once by the block, and afterwards fixed by steaming, called steam colors.

"The slight degree of solubility in a color of this kind is the cause of its direct union with animal or vegetable fibres; because the whole force of the respective affinities of the substance that compose the color, not having been required to produce insolubility, there still remains in each of the con-

stituents, a power of combining with a third substance, or the article to be colored.

"Whereas, in an insoluble color, the whole force of the two affinities having been expended upon each other in order to produce insolubility, there exists no attraction in this compound for the fabric to which it should be applied; hence the impossibility of combining such a color with animal or vegetable tissues.

"Therefore, such colors as are the most insoluble are those whose constituents are drawn together by an attraction so powerful, as to neutralize the affinities which have produced it, and where the metal in the compound exists in a highly oxidized state, and the coloring principle, in conjunction with it, exhibits the character of an acid; and, as these properties of the insoluble color have all to be transferred to the soluble one, before it can possess the utmost degree of permanence of which it is susceptible, the addition of a third substance, capable of communicating these qualities to it, becomes absolutely necessary in the composition of colors for wool or woolen goods.

"It will be seen that the substance to be employed for this purpose must have the power of combining with both the color and the matter that is to be colored, as well as a strong inclination to form a solid combination with them. These powers and tendencies we find to exist in tartar, in an eminent degree, besides having the property of minutely dividing the particles of color, and softening the action of the mordant upon the animal fibre.

"Practice and experience have long ago taught woolen-dyers the advantage of employing tartar as a useful auxiliary in the composition of coloring solutions, without any knowledge of the theory by which these advantages could be accounted for. This accounts for the great use of tartar in such colors as are applied at one operation in woolen-dyeing. Tartaric, citric, oxalic, and other crystallizable acids, modify the shade and render the color more insoluble, but, having great acid

powers, they will quickly re-dissolve their original precipitates, so that they are not so well adapted for this purpose as their super-salts would be, which, having less solubility than the uncombined acids, increase the permanency of the color in proportion to their degree of insolubility and disposition to preserve a solid combination.

"For this reason the salts, with excess of acid, are better qualified to form ingredients in the mordant of a color than their respective acids, when in a free and more soluble state; and, in the whole number of these salts now used by woolen-dyers, the supertartrate of potash (or cream of tartar) is the best adapted to obtain the desired end; but, in cotton-dyeing and calico-printing, no advantageous use can be made of it for this purpose; it will unite with color, but it has no affinity to combine with vegetable fibre; it prevents the fixation of the color upon the cotton fabric, and this resistance by the acid to the application of color to vegetable fibre, is the reason why the proper scarlet color of the woolen-dyer cannot be fixed upon cotton or linen goods in cotton-dyeing or calico-printing, for the excessive acid constitution of this color prevents the complete saturation of the fabric with it.

"The brilliancy of color depends upon the purity of its component substances, and its intensity upon the multiplicity of particles in a given volume of it; or, when the mass of precipitate is minutely subdivided into a vast number of smaller portions of color; or, upon the amount of points from which the colored ray is projected upon the eye.

"In the operation of dyeing, supertartrate of potash promotes this subdivision of the particles of color, and the violence of ebullition greatly accelerates their comminution, as also the high temperature of steam, in the process of fixing colors by steam.

"Those colors whose specific gravities are the greatest, are those whose particles are the most infinite, and, in consequence of this, possess the greatest intensity or vivacity; they are also the most insoluble, and, of course, they will be

the most permanent; they are those colors in whose composition an acid enters, either as the coloring principle, or as a modifier of the colors. They are the mineral colors, or colors that have been made to approach to the nature of mineral colors, by the addition of an acid salt, which has greatly multiplied their particles, and produced the insoluble state in them.

"The affinities of color, for such fabrics as it is customary to dye, are greatest for animal substances; next for vegeto-animal, and, last, for vegetable matters, or, in order, wool, silk, and cotton. In consequence of these degrees of attraction which exist between color, and the substances to be colored, there is found to be a difference in the ease with which they can be imbued with color, in proportion to their respective affinities; and, on this inequality in the attractive forces, originates the necessity of employing different methods and processes for combining the same color with wool, silk, or cotton, in the operation of dyeing them."

From these observations we come to the following conclusions: —

First. That if a metallic or earthy salt is mixed with coloring matter in solution, a precipitate which is more or less soluble is formed. This precipitate is called color.

Second. This precipitate is composed of the oxide of the metal or earthy salt employed and the coloring matter, and a great excess of acid, or of coloring matter, will re-dissolve a part, and sometimes all of the precipitate which was first formed.

Third. The mixed solution, after the color is precipitated, contains the acid of such salts as were employed to precipitate the coloring matter, and, in some cases, retains a small amount of the coloring matter with it; but if the coloring matter should be in union with an alkali (prussiate of potash for instance), in this case, the supernatant liquor contains an alkaline salt, composed of the acid of the metallic or earthy salt and the alkali that was in conjunction with the

coloring matter. Here a double decomposition has been effected, and the solution is colorless.

Fourth. Color may be considered, in relation to dyeing, as of three kinds: the insoluble, the partly soluble, and the very soluble, or liquid.

Fifth. The insoluble will only unite to a fabric by virtue of the affinities which its component parts have, when separate, for the fabric and for each other. It is the most permanent kind of color.

Sixth. The partly soluble more readily enters into combination with the subjects of dyeing in the aggregate state; its sparing solubility aiding it to fix itself on the material to be dyed. It is less permanent than the insoluble kind.

Seventh. The very soluble, or liquid color, may be considered as only a modification of the other kinds, rendered more soluble by the agency of an alkaline or acid menstruum, which, in acting as a medium of solubility, exercises so great an action upon it, as frequently to change its nature and destroy its durability. It very easily fixes itself upon a fabric, and is very fugitive.

Eighth. Color has a natural tendency to combine with animal and vegetable fibre, either in its aggregate state, or by its component parts, separately, being capable of uniting with them; and the effect or result produced by these affinities is termed dyeing.

Ninth. The affinities of color, or its separate constituents, for animal, vegetable, or vegeto-animal substances to be colored, are the greatest for wool; next, for silk and furs; then, for cotton and linen. Woolen and linen are placed at the extreme of the scale, and silk, which is partly vegetable and partly animal matter, occupies a medium situation between the two. Therefore, by combining the methods, &c., for coloring wool and linen, and taking the *mean* result as the determinate manner of dyeing the vegeto-animal matters in general, it ought to give us those processes, &c., which will answer best for silk. Experiment confirms this observation.

Tenth. The brilliancy, brightness, or beauty of color, depends upon the purity of its component substances.

Eleventh. The intensity or vivacity of color, consists in the fineness and number of the particles or points projecting the color, or upon the amount of surfaces reflecting the light.

Twelfth. The permanence of color is in proportion to its approximation to the solid state, or its disposition to form an insoluble compound.

"The insoluble colors are perfectly fast; the partly soluble ones are moderately so; the colors which dissolve to an unlimited extent are very fugitive. But the amount of permanency can be increased in a color possessing little solubility, by the addition of a definite amount of tartar."

It has been shown in the beginning of the above extract, that if a metallic or earthy salt were poured into a solution of coloring matter, it will immediately precipitate the coloring matter, that precipitate being called color, &c. This precipitate will again become soluble in the solution from which it was formed, by boiling the solution, and it will combine with the wool or fabric while in a state of solubility, and after the wool has been brought to the particular depth of color desired, should we continue the boiling, the color is seen to grow poorer, or, we may say, the color boils off. The cause of this phenomenon is, the coloring matter is in excess of the mordant, which causes a reaction to take place; the coloring matter has begun to re-dissolve the precipitate that was formed and had fixed itself upon the wool or fabric. To remedy this we have to give it more mordant by saddening with such metallic or earthy salts as the particular color or shade requires. This boiling off of the color is very noticeable in coloring scarlet, but more especially in coloring black on cotton, when, after the color is brought up rich and full (if the coloring matter in the dyeing bath is in excess of the mordant upon the cotton to take up all the coloring matter), it will begin to grow paler or more slaty colored, the longer

you leave it in the coloring solution, and finally it will come down to a slate color instead of being a black.

This proves that when the coloring matter is in excess, it has the property of dissolving its own insoluble precipitate. This also shows or points out the necessity of the dyer exercising a great amount of care and judgment in proportioning the mordants and dyestuffs in relative quantities, in order that they may saturate each other without having either of them in the bath as a useless superfluity, but if either of them is allowed to exceed the other, let it be the mordant. But to obviate this boiling off, as it is termed, whenever the wool, cotton, or fabric has been brought up to the desired shade, draw off the tub or kettle, or else take out the yarn or cloth for fear of the color changing by too long an exposure to the action of the coloring solution.

REMARKS ON COTTON-DYEING.

Cotton is colored in the raw state, in yarn and in the woven fabric, but more generally in the yarn. All dyers are aware that it is more difficult to fix colors upon cotton permanently than it is either upon silk or wool, as it requires stronger and different mordants for cotton than for wool.

In coloring cotton in the raw state, we abridge the following remarks upon the subject from Gibson's System and Science of Colors: "In dyeing raw cotton, we seem to be performing an operation contrary to its nature, for it has an *obstinate aversion* to imbibe the liquid color, or even the mordant which is intended to combine with the coloring matter, and when by excessive boiling the cotton has been forced to absorb a certain quantity of the liquid, it will retain it with such tenacity that no common draining will clear it from watery solution of the mordant sufficiently to enable it to receive the full benefit of coloring solutions. Its very feeble

affinity for coloring matters is another difficulty that the dyers have to contend with, and colors in most cases seem to combine with it only through the intervention of a third substance." This third substance we will term tannin, or impregnating the cotton with some astringent substance before applying the mordant; this astringent substance we obtain from sumac, nutgalls, or cutch; and for yarn-dyeing, divi divi is used. It appears that cotton has a very strong attraction for the materials named above; therefore, we see the propriety of first giving the cotton the tannin operation before we apply the mordant, previously to immersing it in the coloring solution, especially for dark colors and all other colors that will bear such a foundation."

"The operation of giving the cotton the *tannin* preparation before the mordant is applied, is not so much a dyeing operation as it is a preparatory step to the succeeding processes of fixing the color in the fibre of the cotton. It is not in this sense a dye or color, but only the agent or medium whereby a union is more easily effected between the cotton to be colored and the coloring matter to be used.

"The process of tanning hides and the sumacing of cotton are so similar or identical that the sumacing of the cotton is not inaptly called the *tannin process*, to distinguish from those operations which produce the color."

"When cotton has been subjected to any process preparatory to receiving the coloring matter, whether that process consisted in sumacing or mordanting, or even to partially color it, we have observed that it was very difficult to drain out the superfluous liquor, and that this liquor of the first process being carried in the raw cotton into that of a different kind in the second process, either partially destroyed the latter solution or would prevent it from having its full effect." Therefore, we should use the *extractor* to take out all liquor possible from the cotton before we immerse it in the next solution. In cotton-yarn dyeing, this can be done sufficiently by *wringing* the yarn thoroughly.

"The coloring of wool and the coloring of cotton differ greatly, for the result of dyeing is very different upon the two materials, that of cotton being a *mechanical fixation of color upon* the *fibre* of the *cotton;* but the coloring of wool is a *chemical combination* of the *color within* the *fibres* of the *wool.*"

"The inferiority in point of permanency of colors on cotton to those on wool is the great object of the dyér to overcome, and can only be done by first bringing the cotton into such a state for receiving and retaining color, which he can do by exposing it to the *tannin* process, or by *animalizing* it. Secondly, then, in a fresh bath or solution, submitting the cotton to the mordant process, which is a solution of metallic or earthy salts. Then, finally, subjecting it to the dyeing process in another solution, composed of such coloring matters as that particular color will require, taking care through all these processes to keep them isolated, so that no portion of one solution shall be carried into the succeeding one; and this can be done by extracting the cotton between each process or operation."

REMARKS ON COTTON-YARN DYEING.

Blue is colored upon cotton-yarn by first passing it through a nitrate of iron solution, and afterwards worked through a solution of yellow prussiate of potash, acidulated with either muriatic or sulphuric acid. The yarn should be washed off after it comes out of the iron solution before it is put into the prussiate solution, in order to free it from the superfluous acid and iron; the yarn is then passed through the prussiate solution for fifteen or twenty minutes. Considerable care must be taken in adding the acid to the prussiate solution, or else the color is very liable to change, becoming gray after it is dried. The best method, and most proper one, is first to

dissolve the prussiate in hot water, then to add it to the tub of cold water in which you intend to color; then add sufficient sulphuric acid to the solution to have it perceptible to the taste.

The above method is for eight shades of blue; but for deep shades the yarn is passed through a strong nitrate of iron solution, then from the iron-tub through a potash lye solution (which will fix the iron oxide upon the yarn), then pass it through the prussiate-tub. But a still darker and better blue may be obtained by adding to the nitrate of iron solution some tin crystals. Pass the yarn through this solution, then enter it immediately into the prussiate solution, to which has been added some muriatic acid. You must pass the yarn from the iron solution, without washing, into the prussiate solution. This method gives a full, deep, rich blue, and is the most generally used of any. The muriatic acid gives a purple bloom to the color, which sulphuric acid does not. (See recipes for blue on cotton-yarn.)

Nankeen color is produced by merely passing the yarn through a nitrate of iron solution. This is the easiest color made upon cotton, and at the same time it is very permanent. If the yarn is passed through a weak soap solution after it is taken from the iron-tub, it gives a clearness to the shade; besides, it will soften the yarn; but the yarn must be washed from the iron-bath before it is put into the soap solution.

Purples, reds, clarets, and such shades are produced by first steeping the yarn in sumac, then passing it through the spirit-tub (plumb-tub), then through logwood, with a little spirits. The spirits for these shades vary, and are made differently. The manner of making them can be found in another part of this work. (See Mordants for Cotton.)

In using barwood for any of the above shades, it being so slightly soluble in water, it should be thrown loose into the dye-tub, and after being boiled, the yarn is put into the solution; the yarn, having first been sumacked, and then passed through the spirit-tub, will combine with and take up all the

dissolved color; the water becoming exhausted of color will now dissolve more of the color from the barwood, which will be again taken up by the yarn, and so on until the tin which is upon the yarn becomes saturated with the color. The color is then at its richest and brightest hue. A great deal of experience and attention is required of the dyer to be able to decide the exact time to take the yarn out of the barwood solution, otherwise he may have a brownish red by leaving it in too long, or have a poor color by taking it out too soon. The yarn must be thoroughly washed after coming out of the spirit-tub, before putting it into the barwood solution, for if there were any loose tin-liquor upon the yarn, the dyewood being in the tub, loose, will take up this loose mordant and will become more or less colored, and thus retain a portion of the coloring matter which should go upon the yarn. For this reason the yarn must be washed from the spirits. Inattention to this is the greatest cause of the colors not being of the same shade; even with the best of care and attention the wood-grounds will come out of the bath richly colored.

Purpurine and alizarine are now largely used for coloring reds upon cotton-yarn, as well as for printing red upon cotton-cloth.

Yellow was formerly colored on cotton-yarn by acetate of alumina and quercitron bark, or fustic, which is a fast color on cotton when colored by these substances. In connection with this method of coloring yellow, some very interesting facts were obtained from Mr. Thom by Parnell, who gives them in his Applied Chemistry, from which we abridge the following: "Alumina has a stronger attraction for the coloring matter of madder than for that of logwood, and a stronger attraction for that of logwood than for that of quercitron bark. When a skein of cotton-yarn impregnated with acetate of alumina is immersed into a decoction of quercitron it receives a fast yellow color. If this yarn is washed for some time and kept in a hot decoction of logwood, the alumina parts with the coloring principle of quercitron to combine

with that of the logwood, and the color of the yarn is changed from yellow to purple. Now, if it is next immersed for a few hours in a hot decoction of madder, the alumina parts with the coloring principle of the logwood to unite with that of madder, the color changing from purple to red. The amount of the alumina upon the yarn does not appear to diminish while these substitutions are taking place."

The same law is applicable if we use for a mordant the tin solutions instead of the acetate of alumina; the result is the same in the change of the first named above, for if a quantity of yarn were colored yellow by tin spirits and bark and then put in a hot solution of logwood, a certain amount of the yellow is displaced by the coloring principle of the logwood. Cotton-yarn is colored yellow with acetate of lead and chrome when permanency is not absolutely necessary.

The chrome yellows, so called, have superseded the vegetable colored yellows upon cotton-yarn and cloth. The chromate of lead is not only used for yellows, but also for greens and oranges.

To color a yellow with the chromate of lead, the yarn is first passed through a solution of either the nitrate or acetate of lead; it is then wrung out well and passed through a solution of chrome; the chromate of lead is thus formed within the fibre of the cotton. The yarn is passed first through the lead solution, and then through the chrome for a number of times, if dark and deep shades are desired. There are other shades of yellow obtained by adding muriatic acid to the chrome solution. Yellows produced in this manner are called *acid yellows*.

Green, on cotton-yarn or cloth, is colored by a number of methods. When quercitron bark is used, the yarn is first steeped in sumac, then passed through the spirits, then washed off from the spirits and worked in a decoction of quercitron bark, to which has been added a quantity of muriate of tin (spirits) to raise the color. If the yarn is washed from this, and then passed through a solution of logwood and

Brazil-wood, we obtain a brown. The chrome-greens are produced in the same manner as the chrome-yellows are, being first colored blue by the copperas-vat. In this method the nitrate of lead ($Pb\,O,\,NO_5$) should not be used, as its free acid would destroy the indigo and redden the hue; therefore the acetate of lead ($Pb\,O,\,C_4H_3O_3$) only should be used. The greatest care is requisite in coloring greens by this process, so as to avoid unevenness; the yarn should be well wrung out from each solution, and washed as *soon* as *possible* from the *chrome* solution.

In coloring green with iodine-green, or what is termed the *methyl-green*, the yarn or cloth is first steeped in sumac for a few hours, then rinsed off and wrung out; it is then colored with methyl-green crystals, the marks of which run from B to jjj E, according to the shades produced, the heat for dyeing being 120° Fahr. Some dyers add a small amount of acetic acid ($C_4H_3O_3$) towards the last end of the operation, to brighten up the shade. Another method is to pass the yarn first through the copperas-vat to give it the blue, then pass it through a weak solution of pyrolignite of alumina (Al_2O_3 $2\,C_4H_3O_3+4\,HO$); it is next wrought in a hot decoction of fustic, which gives the yarn a rich, beautiful shade of green. Muslins and gauzes are occasionally colored green with fustic, but the goods go through the same preparations as when coloring with quercitron bark.

The next method is by chemic, or sulphate of indigo process. The yarn is first boiled, and then washed and put through a diluted solution of acetate of alumina, and washed from this in hot water. It is then worked through a decoction of quercitron bark, or flavine, and when the yarn has acquired sufficient yellow color for the shade of green wanted, it is then passed through a quantity of chemic, added to cold water. It is wrung out from the chemic solution, and dried. The chemic for this purpose must be neutralized with soda; if not, the free sulphuric acid in the chemic would destroy the yellow, and spoil the looks of the green color.

Some dyers first color the yarn a Prussian blue; then finish off with fustic or quercitron bark.

Black: There are numerous methods for producing a black upon cotton yarn. (See recipes for blacks.)

Browns are now mostly produced by catechu and chrome, by first passing the yarn through a solution of catechu or cutch; then through a chrome solution. In coloring browns with catechu, the threads of the yarn are apt to adhere together when the yarn is dried. This is owing to the gummy nature of the catechu; but by adding some blue vitriol to the catechu solution, this objection can be avoided. The reason of this chemical change in the nature of catechu, is that the blue vitriol oxidizes a portion of the catechu, and although the gum in the catechu is insoluble in water, it becomes soluble in deoxidized catechu. Therefore, all of it is held in solution in the bath. This, however, does not account for all the phenomena occurring during the coloring of browns with catechu; for if we should take two portions of a solution of catechu, and to one portion of it add blue vitriol ($Cu\ OSO_3$ or $Cu\ SO\ 4+5\ H\ 2\ O$), and to the other portion add a salt of zinc; for instance, sulphate of zinc ($Zn\ OSO_3$ or $Zn\ SO\ 4+7\ H_2O$), and then pass a skein of yarn through each; then pass these through a solution of lime, and expose them to the air, we will find that the skein which was passed through the zinc will be a dark brown, whilst that passed through the blue vitriol will be more of a cinnamon-brown color; but this would naturally cause us to expect the opposite result, as we know that copper (blue vitriol) gives up its oxygen more easily than zinc does.

When yarn is first passed through a solution of catechu, and then passed through a chrome solution, we obtain a deep brown. The oxidation of the catechu takes place at the expense of the chromic acid ($Cr\ O_3$.)

Whether the oxide of chromium (Cr_2O_3) acts as a base on any part of the dye, is not positively known; yet, if we should burn a piece of the yarn colored brown by this process, we

will find in the ash both the chrome and copper oxides, proving that both the blue vitriol and chrome which are used, act a part in forming the color, and also that the color obtained by this method is something more than the mere oxidation of the catechu.

Browns are sometimes produced by first steeping the yarn in sumac, then passing it through a solution of tin crystals, or through the spirit-tub; then again work through a decoction of bark, to which has been added a certain amount of spirits. The yarn is washed from this, and then finished in a solution of hypernic and logwood. The proportions of these woods vary according to the shade of brown desired.

The aniline browns are produced by first sumacing the cotton, and then spiriting as described for the other colors, and thoroughly rinsing off in cold water containing a very little aqua ammonia (NH_3+HO), in order to neutralize every trace of the acid contained in the spirits. The cotton is dyed at 120° Fahr., with the aniline brown powder.

Orange color on cotton is produced by different methods, the most general method now adopted being the chrome-orange, and which is obtained by fixing upon the goods the sub-chromate of lead, as in the coloring of chrome-yellows, and then passing the yarn through a hot lime solution, which will combine with the chromic acid, forming a deep orange color. This passing the yarn through the hot lime solution is called or termed the *raising* of the orange, and is a very trying and difficult operation; for if the lead solution has not been properly made, or not completely fixed upon the yarn, when we come to pass it through the hot lime, the yellow will be stripped from the yarn; and should the lime solution be much below the boiling point, the color would be discharged. Care must be taken to keep the lime solution at the *spring of the boil*, as the higher the temperature of the solution, the less lime is held in solution, thereby avoiding the risk of a failure. If an orange is once uneven, it is a very difficult matter to get it even again.

In preparing the lead solution, great care is necessary to have the proportions of lead and litharge so that they will combine; the tribasic acetate of lead should be used for this purpose, which is a combination of three parts of lead, and one part of acetic acid; this being the best combination for producing oranges and deep yellows. Some dyers use a small quantity of lime, which causes a loss, as the lime combines with the acetic acid in the lead, and forms an acetate of lime ($Ca\,O\,C_4H_3O_3$), which would prevent a portion of the litharge from dissolving. Should the lead, litharge, and lime not be boiled long enough, the lime would convert the acetate of lead into the tribasic state (which is what we wish to do); but, it will be observed, that this is at the expense of the lead, which we are intending to use for the production of the color. The proportions of acetate of lead and litharge vary, some dyers using equal parts; the proportions which we believe to be correct are, six parts of crystallized acetate of lead ($Pb\,O,\ C_4H_3O_3+3\ HO$), eight parts of litharge ($Pb\,O$), and thirty parts of water, these to be boiled until all the litharge is dissolved. In coloring with lead solutions in water that contains sulphate or carbonate of lime, the lead will be precipitated; the lead is also lost, it being rendered insoluble and useless as a dye, as every ounce of carbonate of lime will render useless a little more than five ounces of lead. When the basic acetate of lead ($Pb\,C_4H_3O_3$, brown sugar of lead) is used, the proportions are twenty-five parts of lead to fifteen of litharge. The acetate and the litharge are put into a boiler half full of water, it is then boiled until all the litharge is dissolved, then there is one pound of lime added to it and allowed to settle; the clear liquor is put into another tub; seven pounds of chrome are dissolved in a tub or vessel by itself, for coloring; two other tubs, large enough to hold the amount of yarn that is to be colored, are filled with water; to one is added some of the lead solution, to the other some lime-water; the yarn is then worked in the lead-tub and wrung out; then passed through the lime-water, and

wrung out; then more of the lead solution is added to the lead-tub, and the yarn is again passed through it; then add more lime-water to the lime-tub, and pass it through that, wringing the yarn out at each immersion; it is then passed through the chrome solution, then through hot lime-water. (See recipe for fast orange on cotton-yarn.)

CALICO-PRINTING.

This very important branch of industry (we might say of the dyer's art), aims at producing colored patterns upon calico, linen, and silk tissues. Calico-printing is the most important part of the dyer's art, as it is based upon the same principles as that of dyeing, but is, in the practical execution of it, far more difficult; partly, because the colors have to be applied to certain portions only of the fabric, while others either have to remain colorless or are discharged; partly also because it is frequently the case that many colors have to be applied close to each other.

The colors employed in calico-printing are of two different kinds, the first being such colors as are directly applied to the cloth by the aid of copper-cylinders, upon which the designs or patterns to be produced on the cloth are engraved.

To the colors thus applied, belong such as the ochres, Berlin blues, madder-lake, indigo, cochineal, and nearly all of the tar colors. The second kind of colors are such as are produced by immersing the cloth printed with the various mordants in dye-baths, such as madder, cochineal, logwood, sumac, and cutch; the yellow-coloring dyewoods, &c., belong to this kind. The various methods of printing are chiefly the following:—

First. From the thickened and mordanted colors.

Second. The thickened mordant only is applied, by means of the engraved copper cylinders, to the cloth, which,

after the mordant has been thoroughly fixed, is passed through the dye-beck.

Third. The entire piece of cloth is either mordanted, or a color is printed, while to such portions of the cloth as are to remain white or are intended to be afterwards of another color or colors, or pattern, a resist is put on, sometimes printed from the cylinders, the result being that on the portions of cloth thus protected with any of the various *resists*, the color will not become fixed.

Fourth. Colors may be, and in practice are, largely produced by first coloring the mordanted cloth with one kind of color, and then removing this color in certain portions of the cloth by chemicals which will destroy the color, these chemicals being *technically called discharges.*

In order to fix certain colors upon cotton-cloth, they have to be steamed; such colors are termed steam-colors; while such substances as ultramarine, Guignet green, and the lakes of madder, which are applied mechanically by the assistance of albumen, caseine, and gluten, which require the aid of steam for their fixation, are termed, technically, surface-printed colors.

The mordants used in calico-printing are mostly such salts as are, comparatively speaking, loose combinations of acid and base, so that the base can easily unite with the fibre; and among the mordants mostly used, iron and acetate of alumina ($Al_2O_3C_4H_3O_3$) occupy the first position, while a solution of aluminate of soda or alum is more rarely used. Acetate of lead ($Pb\ C_4H_3O_3$) is the mordant for producing chromate of lead ($Pb\ Cr\ O_4$). The various combinations of tin are also used as mordants. A mixture of caseine (curd of milk) and lime is sometimes used as a mordant in calico-printing, and is known in England by the technical name of *lactarine.* Caseine is prepared from the curd of milk; it is dissolved in weak caustic ammonia, and the solution thus obtained is mixed with freshly prepared milk of lime (lime-water). When this substance is used for a mordant, the cloth is steeped

in it previous to being colored. The cloth is dried after being taken out of the caseine-lime bath. The drying causes the caseine to remain in an insoluble state in the fibre of the cloth, and will resist washing with soap and alkaline fluids. When the cloth is dried from this mordant it has a peculiar stiffness, so that although its affinity for coloring substances has become nearly equal to that of wool, it is far behind wool, owing to its lack of lustre; but to avoid this stiffness, this mordant is mixed with Gallipoli oil previous to steeping the cloth in it. Tannic acid, albumen, dried white of eggs re-dissolved in water, and vegetable gluten are used as mordants in calico-printing. In using caseine and lime for a mordant, we are not limited merely to the mineral colors; for by its use the various vegetable colors can be fixed upon the cloths by first converting the vegetable coloring matter into lakes by means of alumina or the salts of tin, and then using these lakes in the same manner as powdered mineral colors. When cloth is mordanted with the caseine and lime process, and printed with the mineral colors, very full colors are obtained, which in many patterns would not be desirable. This objection is remedied (when we wish to bring out the shades and half-colors in the full-colored impressions) by placing the printed cloth upon an absorbing ground, with the colored or face side of the cloth upon this absorbing ground, and then pressing the forms on the back of the cloth; this will deprive the cloth of some of its color, and by this process numerous patterns can be produced.

Thickenings: In order to give the colors or mordants used in printing, either by block or cylinders, the proper consistency, there is mixed in them what are called thickenings, which consist of such substances as Senegal gum, tragacanth, leicome, British gum, dextrine, salep, flour, gluten, pipe-clay with gum, glue and size, sulphate of lead, sugar, molasses, glycerine, starch, and sometimes chloride and nitrate of zinc ($Zn\ Cl - Zn\ ONO_5$). The colors and mordants depend for their purity upon the quality of the thickenings. British

gum made from starch is most generally used. In the selection of thickenings we should keep in mind that those mordants that are very acid in their nature cannot be mixed with starch, because the starch will lose its consistency when mixed with a substance that is very acid; and again, such metallic preparations as basic or sub-acetate of lead, the solutions of tin, and nitrate of copper and of iron will coagulate gum; for which reason it should not be used as a thickening for the above substances.

In calico-printing there are used compositions called *resists* or *reserves*, which, when printed upon the cloth, prevent any of the colors from fixing themselves to that part or portion of the cloth which has this resist composition printed upon it; the result being that those parts or portions will be left white. Most generally the resist is used with the view of preventing the fixation of indigo to certain parts of the cloth, so that it shall remain white where these resists are applied. The same results are obtained by *discharges*, which we shall notice hereafter.

The resists are made up from pasty substances, such as pipe-clay, fat, oil, and sulphate of lead ($Pb\ SO_3$); to these are added such substances as will readily yield oxygen; for instance, sulphate, nitrate, and acetate of copper, a mixture of red prussiate of potash and caustic soda solution.

There are cases where resists are composed so that they act as a mordant (alumina or iron mordants) for other colors, the parts of the cloth on which the resist is printed and left white being colored by passing the cloth through the dye-tub or dye-beck which contains another dyestuff in solution, which may be madder, quercitron bark, or some other dyewood. The so-called *white resist*, for cylinder printing, consists of acetate or sulphate of copper, or acetate of lead, thickened with gum or dextrine solution. After this composition has been printed on the cloth by the cylinders, the pieces are run through the indigo-vat until the depth of color desired is obtained. They are then passed through an acidu-

lated bath until the parts on which the resist was printed have turned white. The *rationale* of this process is the following: "As soon as the reduced or white indigo in the vat comes in contact with the oxide of copper ($Cu\ O$) it is converted, at the expense of the oxygen of the oxide, into blue indigo, which is precipitated in an insoluble state on the resist. By the treatment with dilute sulphuric acid, the hydrated sub-oxide (red oxide) of copper is dissolved, and with it the indigo washed out."

Instead of the salts of copper, white resists are used, and these are composed of bichloride of mercury ($Hg\ Cl_2$) and sulphate of zinc ($Zn\ OSO_3$). The mercury acts in a similar manner to the salts of copper, and the copper enters into an insoluble combination with the reduced (white) indigo, which is precipitated wherever the resist has been applied.

Discharges: These substances are for the purpose of producing, by chemical means, white designs or patterns upon colored grounds; or, in other words, upon colored cloth. This is done by destroying or discharging the color which had been previously dyed upon the whole surface of the cloth, or by dissolving a previously applied mordant. To discharge the applied mordant, certain acids are made use of, such as phosphoric, arsenic, oxalic, lactic, &c. These are made to combine with the base contained in the mordant; but for the purpose of discharging the previously applied color, such substances as bleaching-powder, chromic acid, a mixture of red prussiate of potash and caustic lye, permanganate of potash ($KO,\ Mn_2O_7$), a paste composed of bromine (Br) mixed with water and pipe-clay, nitric acid, &c., are used. All these agents have an oxidizing effect, but tin crystals ($Sn\ Cl$) and copperas (sulphate of iron) which are also used for discharges, act as a discharge by absorbing oxygen. Among the acid discharges, tartaric acid ($C_4H_2O_5$) is generally used for this purpose, and alumina and oxide of iron employed as mordants; sometimes this acid is mixed with bisulphate of soda ($Na\ HSO_4$).

A piece of cloth that is colored either red or blue, to which is, in certain parts, applied a mixture of tartaric acid and pipe-clay and gum (the latter as a thickening to give consistency), will be almost instantly bleached if the cloth so prepared should be passed through a solution of bleaching-powders.

Reducing Agents as Discharges.

Protochloride of tin ($Sn\ Cl$ = tin crystals) is the most important of all the reducing agents which are applied to goods colored with the oxide of iron. If tin crystals are placed in contact with oxide of iron, the result would be the formation of readily soluble protochloride, which is easily removed by simply washing, while, at the same time, there is deposited upon the fibres of the cloth proto-peroxide of tin.

Oxidizing Agents as Discharges.

The discharging of the indigo-blue from the calico is owing to the formation of *isatine* ($C_{16}H_{10}N_2O_4$) from the *indigo-blue* ($C_{16}H_{10}N_2O_2$), the *isatine* being soluble and the *indigo-blue* being insoluble in water, so that the soluble substance can be taken out by washing.

Indigo is also discharged from the cloth by chromic acid ($Cr\ O_3$) which is used as bichromate of potash ($K_2\ Cr_2\ O_7$), the acid being reduced while giving off oxygen to the chromic oxide ($Cr_2\ O_3$).

Calico may be printed by the three following methods: —

First. Dyeing in the dye-beck (so called).

Second. By block or cylinder printing (topical color-printing).

Third. By resist or discharge printing.

In the process employed in coloring in the dye-beck (madder style, so called), the thickened mordant having a faint coloring matter added to it for the purpose of recognition (we must bear in mind that the mordants are nearly colorless), the pattern produced on the white cloth is imprinted by the means of either blocks or cylinders, upon

which the desired pattern is engraved. Cylinders are now generally used for printing calico, they being made of copper, on which the pattern is engraved. These cylinders are revolved by the aid of machinery. There is also a wooden cylinder connected, which is covered with cloth or felt, which dips into the vessel that contains the mordant, the copper cylinder being fed with the mordant from this wooden roller or cylinder. Connected with the copper cylinder is a kind of blunt knife, technically called the *doctor*, which scrapes off all the superfluous color from that part of the cylinder on which there is no engraved portion of the design or pattern.

Before the mordanted cloth is colored it has to be kept for some time, so that the iron and alumina mordants will combine more intimately with the fibre of the cloth (technically termed ageing). After this ageing process, the cloth has to undergo a cleansing operation before it is entered into the dye-beck; that is to say, the mordant has become dry, by the ageing it has had, so that the thickening and faint coloring matter, together with any loose mordant that may be uncombined with the fibre, must be removed by the cleansing operation. For those goods which are intended to be madder-dyed, the cow-dung bath is required. Usually some chalk is added, to saturate the acetic acid or the mordant. All calico-printers agree that the cow-dung bath is requisite, yet the *rationale* of the action of the cow-dung bath has not yet been fully explained.

Mercer substituted certain phosphates and arsenates for the cow-dung, and obtained good results, and he proposes the use of phosphate of soda (2 Na O. PO) and phosphate of lime (3 Ca O. PO). In England, cow-dung is rarely used now, as it has been superseded by silicate of soda. After the cloths have been cleansed with cow-dung, or its substitutes, they are washed, and then they are colored. It is clearly seen that where there are different mordants printed upon the cloth, a number of colors can be brought out upon the same piece and with the same dyestuff. For instance, all

shades of pink and red, black, brown, violet, and lilac, can be produced with madder, if alumina and iron mordants and mixtures of these have been used as mordants, for the color will only fix itself upon that portion of the cloth where the mordant has been applied, so that by washing the cloth, after it comes out of the dye-beck, with bran and soap, the superfluous color can be removed. This washing operation is termed *clearing.* In some cases, the madder-colored cloths are cleared with solutions of bleaching-powder. Some dyes, in order to bring out their most brilliant tints, have to be cleared by other means than that named above. For instance, the Turkey-reds, after coming from the finishing or dyeing bath, are submitted to a boiling, *under pressure*, with soapsuds and muriate of tin or tin crystals.

Topical or Surface Colors.

This consists of applying the mordants and the thickened color to the cloth at the same time, or in other words, simultaneously, the colors and pigments being termed *topical or surface colors*, and is known as *topical* or *surface* printing. There are two varieties of surface colors known; one of them is in the state of a solution when it is printed upon the cloth, which becomes gradually fixed and insoluble on the fibre itself. The other variety is applied in the insoluble state with plastic substances and the thickening, these aiding or assisting the colors to adhere to the fibre, so that a simple washing does not remove them; ultramarine is applied by this process. This manner of printing requires the aid of steam to fix as well as to clear the colors, and they are called *steam colors.* This method of printing is now very extensively adopted. After the goods are printed in this manner, they are dried and then hung up in a room fitted for this purpose, and exposed to the action of steam at 100° Fahr., or more. The length of time the goods are thus exposed depends upon several conditions, and varies in different print-works, each color-mixer or printer having his own par-

ticular time, but the time is generally from twenty to fifty minutes.

Discharge Style of Printing.

The term *discharge* is given to any composition that has the properties of bleaching or discharging the color which has been put upon the cloth or fabric. As a general rule, discharge is applied to goods of one color, such as indigo and Turkey-red colored fabrics, upon which it is required to have white patterns; and sometimes, upon a portion of these white patterns, other colors are produced. The substances used for the discharge vary with the color which was on the cloth, as well as with the color intended to be produced afterwards on the white portion; and the discharge is made or prepared in such a manner that it must not injure the fibre of the cloth.

Such materials as oxalic, tartaric, citric, diluted muriatic, and sulphuric acids, bisulphate of potash, nitrate of lead, solutions of bleaching-powder, weak chlorine water, and the bichloride of tin are used; these being thickened with suitable materials, some of them are so manipulated as to serve as mordants for some of the colors to be applied after the discharge; for instance, for yellow, nitrate of lead, with tartaric acid, starch and water; for black, nitrate of iron, added to a decoction of logwood; for Berlin blue, tin-crystals, farina, and water are used.

These discharges having been printed on the cloth, it is then put into a solution of chloride of lime, and passed through it, the color which was on it, when the discharge is printed, is destroyed, and, in its place, the color desired is produced according to the design. Chromic acid, or a solution of bichromate of potash acidulated, is often used as a discharge; the oxide of chromium (Cr_2O_3) produced will yield a brown color.

Aniline Printing: As regards the application of aniline colors to printing, we think that they may be termed *steam*

colors. The printing and fixing of these colors is effected by the following methods.

First. "The thickened mordant is printed on, and next fixed either by drying, or by ageing and steaming after drying, the cloth being dyed in a solution of the aniline (red, violet, blue), the color becoming fixed to the mordanted portions only of the cloth."

Second. "The thickened mordant is mixed with the aniline dye, and then printed on the cloth, and the fixing effected by steaming." "The mordants used in this method are: dried albumen, blood albumen, the latter being bleached by the action of ozone obtained by means of oil of turpentine, vegetable gluten in various forms." Instead of gluten, caseine can be used, dissolved in caustic lye, or in acetic acid. Kuhlmann and Lightfoot recommend tannate of glue. When gluten is used as a mordant, it is first moistened, and then allowed to remain until it becomes sour. It is then purified, first treating it with carbonate of soda ($Na\ O.CO_2$), which renders the gluten insoluble. It is then washed, and again re-dissolved in caustic soda lye. This solution is diluted with water, and then printed upon the cloth, which is then dried, aged, and steamed. After this the cloth is washed in water, and then colored in a solution of aniline. Sometimes gluten is mixed with the aniline dye, and then printed upon the cloth, after which it is steamed, then washed, and steamed again. When caseine (lactarine is its technical name in England) is used as the mordant, it is first dissolved in caustic soda ($Na\ O.HO$), and after the cloth has been printed with this mixture, the aniline color is printed on.

The method of aniline-printing, which was devised by Gratrix and Javal, consists in preparing an insoluble compound of tannic acid. ($C_{54}H_{19}O_{31}+3\ HO$), and an aniline dye, which is thickened with Senegal gum, and then printed upon the cloth, which has been previously mordanted with tin-crystals, or some other suitable mordant; or there is printed upon the cotton cloth a mordant composed of albumen, caseine, or

gluten. The cloth is then dried and passed through an acidulated solution of aniline. The first method given above (which is an aniline-tannin compound) is prepared by adding to the aniline solution as much decoction of galls (solution of tannin would be better) as is requisite to completely precipitate the aniline color. This precipitate is collected upon a filter, washed, and dissolved in acetic acid ($C_4H_3O_3$), and when thickened with gum, the solution is used for printing. After the printing the goods are steamed, and washed either with or without soap. A red color requires a soap-wash. According to the second method, the cloth is treated with a stannate of soda, after which a tannin-containing material is printed upon the cloth, which is then steamed, which fixes the mordant. The dyeing operation is done in a dye-beck, the same as is employed for madder colors. The beck is filled with water acidulated with acetic acid, and heated to about 50° Fahr. The cloth is put into this liquid, and the aniline, dissolved in acetic acid, is added to it gradually; and when the requisite amount of color is added, the bath is heated to the boiling point. Aniline black is obtained on cotton-yarn and cloth by the means of chlorate of potash ($K\,Cl\,O_3$), chloride of copper ($Cu\,Cl$), ferricyanide of ammonium, or freshly precipitated sulphuret of copper. Naphthylamine violet is now obtained on cotton-cloth by very much the same process.

The reader of this article, but more especially the calico-printer, or color-mixer, must bear in mind that the writer is not a *practical calico-printer*, and, therefore, allowances must be made for the errors there may be in the theory advanced; for we have compiled it from knowledge obtained by intercourse and conversation with men who have been practical calico-printers for most of their lives, and the author acknowledges his obligations to these gentlemen for the practical observations and theories communicated to him from time to time, which had not come under his own observation; for

without their assistance in this respect, he could not have given so correct or simple an explanation of calico-printing. The article has not been written by a Persoz, a Gratrix, or a Spirk, but by a dyer, and not by a calico-printer; therefore, it must not be criticised as though it emanated from the brain or pen of a learned professor or practical chemist.

The following mordants, preparations, and colors for calico-printing were translated and compiled by Dr. T. P. Shepard of Providence, R. I., who has kindly permitted me to insert them in this work. They were compiled for the use especially of the large calico-printing establishments in the vicinity of Providence, and they were found very useful, the recipes being modern and correct ones. We abridge from the preface to his work the following:—

"Much that is valuable has been necessarily omitted to bring it within the compass of so small a book; but it is believed that it contains much which will be useful to the managers of print-works. For it cannot be without interest to them to compare their own processes with those current abroad; and with regard to what is familiar in any art, it is of some consequence to discover that nothing better is known elsewhere. In this art, however, many important improvements have been made within a few years, the knowledge of which has not become widely diffused among American calico-printers, owing to the fact that they have been, for the most part, published in a foreign tongue."

And to supply the American printers with this information was the object chiefly of Dr. Shepard in translating these recipes, and publishing them in book-form. He claims nothing more for it than its being a hand or text book for a practical printer, and makes no pretence to fill the place of

the great work of Persoz on calico-printing. We acknowledge our obligations to him for the courtesy extended by allowing it to be embraced in this work.

MORDANTS.

1. *Pyrolignite of Alumina, at 11° B.*

In $1\frac{1}{2}$ gallons of Boiling Water, dissolve
5 lbs. of Alum,
4 lbs. of Brown Sugar of Lead.
Gives 16 lbs. of clear Mordant, at 11° B.

2. *Acetate of Alumina, at 8° B.*

In 11 pints of Boiling Water, dissolve
4 lbs. 6 oz. of Alum,
5 lbs. 13 oz. of White Sugar of Lead.
Gives $15\frac{1}{4}$ lbs. clear Acetate, at 8° B.

3. *Acetate of Alumina, at 15° B.*

4 lbs. 10 oz. White Sugar of Lead,
5 lbs. 12 oz. Alum. Dissolve in
11 pints Water.
Gives $15\frac{1}{2}$ lbs. clear Solution, at 15° B.

4. *Neutral Acetate of Alumina, at 10° B.*

In 13 pints of Water, dissolve
$4\frac{1}{2}$ lbs. Alum,
6 oz. Soda Crystals, and
3 lbs. 6 oz. White Sugar of Lead.
Gives $17\frac{3}{4}$ lbs. clear Mordant, at 10° B.

5. *Iron Liquor Decoction, for Black, at 9° B.*

7 lbs. 10 oz. of Iron Liquor, at 14° B.,
14 lbs. Pyroligneous Acid, at 2° B.,
6 oz. Arsenic,
are boiled together for 15 minutes.

6. *Iron Liquor Decoction, at 10° B.*

$10\frac{1}{2}$ quarts Iron Liquor, at 10° B.,
2 quarts Pyroligneous Acid, at 2° B.,
$2\frac{3}{4}$ lbs. Arsenic,
$2\frac{3}{2}$ lbs. Saltpetre,
are boiled together for half an hour.

7. *Acetate of Protoxide of Iron, or Standard for fast Purple, at 10° B.*

In 7 quarts of Boiling Water, dissolve
3 lbs. 9 oz. Copperas, and
3 lbs. 9 oz. White Sugar of Lead.
Gives 15 lbs. clear Standard, at 10° B.

8. *Acetate of Protoxide of Iron, or Purple Standard, at 11° B.*

In 11 pints of Boiling Water, dissolve
3 lbs. 14 oz. Copperas, and
2 lbs. 11 oz. White Sugar of Lead.
When dissolved, add
3 lbs. 14 oz. Pyroligneous Acid, at 2° B.,
Gives $17\frac{1}{2}$ lbs. Standard, at 11° B.

9. *Nankeen Standard, No. 1, 15° B.*

5 lbs. 6 oz. Copperas,
4 lbs. 2 oz. White Sugar of Lead, dissolved in
$1\frac{1}{2}$ gallons Boiling Water,
Gives $15\frac{3}{4}$ lbs. clear Mordant, at 15° B.

10. *Nankeen Standard, No. 2.*

$6\frac{1}{4}$ lbs. Copperas,
3 lbs. 3 oz. Brown Sugar of Lead,
$1\frac{1}{2}$ gallons Boiling Water.

11. *Nankeen Standard, No. 3, 25° B.*

In 19 lbs. Nankeen Standard, No. 1, dissolve
2 lbs. 14 oz. Copperas.

12. *Orange Standard, or Basic Acetate of Lead, 50° B.*

11 pints of Water,
$2\frac{3}{4}$ lbs. Litharge, and
$4\frac{3}{4}$ lbs. White Sugar of Lead, are boiled together to complete the solution, the water that has evaporated restored, and then
3 lbs. 7 oz. White Sugar of Lead added and dissolved.

Gives 21 lbs. clear Orange Standard, at 50° B.

13. *Orange Standard, or Basic Acetate of Lead, at 55° B.*

5 quarts of Water,
$5\frac{1}{4}$ lbs. Sugar of Lead,
2 lbs. 10 oz. Litharge, are boiled together until complete solution is effected. Then add water until the desired degree is attained.

14. *Blue Standard for Steam Brown or Chocolate.*

7 lbs. Yellow Prussiate of Potash,
10 oz. Chlorate Potash, dissolved in
5 quarts Water (warm) and boiled with
2 lbs. Oil Vitriol in 1 quart of water until the liquor gives no blue precipitate with a solution of per salt of Iron.

15. *Gray Standard for Gray A. G.*

$1\frac{3}{4}$ lbs. ground Logwood stirred into
10 quarts of Boiling Water for 5 minutes, then passed through a fine sieve,
Give $15\frac{1}{2}$ lbs. clear liquor.

10 lbs. 2 oz. of this clear liquor are boiled for five minutes with a solution of
½ ounce of Bichromate of Potash in
½ pint of Water, and
1½ ounces of Muriatic Acid.

16. *Sulphate of Chrome, at 35° B.*

Prepared with Molasses, and therefore sometimes called Sugar-Mordant.
4 lbs. 6 oz. Bichromate Potash, dissolved in
11 pints of hot Water; add gradually a mixture of
2¾ lbs. Oil Vitriol, and 3 pints of Water.
Stir well and immediately add, in small portions at a time,
1 lb. 2 oz. of Molasses.

PREPARATIONS.

17. *Acetate of Chrome.*

1½ lbs. of Bichromate of Potash, dissolved in
2 lbs. Oil Vitriol, diluted with 5¼ quarts Water.
To this solution add, in small portions at a time,
½ lb. Wheat Starch.
When the action is over and the liquid cool, add
5 lbs. 11 oz. White Sugar of Lead.
Let settle, and use the clear liquid.

18. *Acetate of Indigo.*

4 lbs. 11 oz. of Sulphate of Indigo, at 60° B., are decomposed with a solution of
4 lbs. 11 oz. Sugar of Lead in 9½ pints of Water.
Stir well and mix in
6 oz. Quicklime, slacked with 1 pint of Water.
Gives 10½ lbs. clear solution, at 13° B., or 13½ lbs. clear solution, at 10° B.

19. *BB. Blue Bath for Steam Green.*

In 2 gallons of hot Water, dissolve
3 lbs. of yellow Prussiate of Potash,
$\frac{1}{2}$ lb. Tartaric Acid, and
$\frac{1}{2}$ lb. Oxalic Acid.

20. *Iron Composition for Steam Gray C.C.*

8 lbs. 6 oz. Acetate of Iron (protoxide), at 10° B., No. 7.
11 lbs. 10 oz. Nitrate of Iron, at 50° B. Mix.

21. *Muriate of Iron, at 40° B.*

$4\frac{3}{4}$ lbs. Iron Turnings dissolved, cold, in
$15\frac{1}{4}$ lbs. Muriatic Acid,
Gives 12 lbs. 6 oz. of solution, at 40° B.

22. *Oxidized Logwood Liquor, at 6° B., for Black.*

6 lbs. Logwood Liquor, at 20° B.,
7 quarts Water,
3 oz. Muriatic Acid,
Boiled together for 5 minutes.

23. *Ammoniacal Solution of Cochineal.*

On 8 lbs. of Cochineal, pour
12 lbs. Aqua Ammonia.

Cover the vessel and let stand in a moderately warm place one or two days. Then extract the color from the mass with hot water, until the water is no longer decidedly red. Boil down the extract to 4° B. The above proportions give 7 lbs. of solution of Cochineal, at 4° B.

24. *Oxide of Tin.*

In 4 quarts of Water, dissolve
3 lbs. Tin Crystals; to this solution add
4 lbs. Soda Crystals, dissolved in 4 quarts of water. Collect the precipitate on a filter and drain well.

25. *Tartrate of Tin and Potash.*

1 lb. Tin Crystals dissolved in
5 quarts of Water. To this solution add a solution of
$1\frac{1}{4}$ lbs. Soda Crystals in 5 quarts of Water. Collect the precipitate on a filter, and wash it well, and then dissolve it in a solution composed of
1 lb. of Cream of Tartar in
1 quart of Water.

26. *Tin Composition, at 55° B., for Scarlet S. K.*

9 lbs. Tin Crystals,
$4\frac{1}{2}$ lbs. Muriate of Tin, at 50° B., and
$2\frac{1}{4}$ lbs. White Sugar of Lead are dissolved in
$4\frac{1}{2}$ pints Water.
The clear liquor (after standing to settle) is used to brighten Reds.

27. *Tin Composition for Orange S.*

$7\frac{1}{2}$ lbs. Muriate of Tin, at 55° B.,
$3\frac{3}{4}$ lbs. Tin Crystals, added to
$7\frac{1}{2}$ pints of Water. Then dissolve in this,
1 lb. 6 oz. White Sugar of Lead.
Let settle, and use the clear liquor.

28. *Sapan Pigment.*

In 1 quart of Water, dissolve
4 oz. Sapan Liquor, at 20° B. Add to this gradually a solution of
$\frac{1}{2}$ oz. Alum,
$\frac{1}{2}$ oz. Bichromate Potash in
1 quart of Water.

Stir well and let the precipitate settle. Pour away the supernatant liquid, and wash the precipitate several times with water. Then collect it on a muslin strainer, and squeeze dry.

29. *Chrome Orange Pigment.*

1 lb. 14 oz. White Sugar of Lead are dissolved in
13 gallons Water. To this add gradually a solution of
13 oz. of Bichromate of Potash in
13 gallons of Water.

After stirring well, let the yellow precipitate (Chromate of Lead, $Pb\ Cr\ O_3$) settle. This soon takes place. Then draw off the supernatant liquor, and wash it (the precipitate) 3 or 4 times, with fresh water each time.

In order to change this pigment from yellow to orange, it must be boiled in lime-water containing 1 ounce of lime in 50 gallons of water. The easiest way to make this is to take 20 gallons of water which has stood several days over a few pounds of lime, and thereby has become saturated with it; and add these 20 gallons of saturated lime-water to 30 gallons of water.

After boiling 5 to 8 minutes, the yellow color of the precipitate changes to orange. It is then left to settle, and washed as before with fresh water, until the wash-water ceases to be tinged yellow by it. It is then drained well on a muslin strainer, and sqeezed out. The orange pigment is a variable mixture of basic chromate of lead ($2\ Pb\ O,\ Cr\ O_3$) and neutral chromate of lead ($Pb\ O,\ Cr\ O_3$).

30. *Nitrate of Iron, 50° B.*

$2\frac{1}{2}$ lbs. clean Iron Turnings in
20 lbs. Nitric Acid, 36° B.

31. *Nitrate of Protoxide of Iron.*

In 7 pints of Boiling Water, dissolve
$6\frac{1}{2}$ lbs. Nitrate of Lead, and $6\frac{1}{2}$ lbs. green Copperas.
Gives, after straining, 9 lbs. liquor, at 32° B.

32. *Nitrate of Zinc, at 50° B.*

In 20 lbs. Nitric Acid, at 36° B., dissolve
$3\frac{1}{4}$ lbs. best Lehigh Spelter.
When dissolved, bring to the desired degree with water.

33. *Nitrate of Alumina, at 17° B.*

In 5 quarts of hot Water, dissolve
5 lbs. Alum,
2 oz. Soda Crystals,
5 lbs. Nitrate of Lead.
Gives 12 lbs. clear liquor, at 17° B.

34. *Nitrate of Alumina, at 18° B.*

5 lbs. Nitrate of Lead,
5 lbs. Alum, dissolved in
5 quarts of Water.

35. *Prussiate of Tin for Steam Blue.*

11 lbs. Tin Crystals, dissolved in
20 quarts of Water. To this add a solution of
$8\frac{1}{2}$ lbs. Yellow Prussiate in 20 quarts of Water.

The precipitate (Prussiate of Tin, Sn_2Cfy) is to be washed several times by decantation, then collected on a muslin strainer, and well drained.

36. *Iron Standard for Mode Colors.*

14 lbs. Iron Liquor, at 14° B.,
$4\frac{1}{2}$ lbs. light-colored British Gum.

37. *Sulphate of Indigo, at 61° B.*

4 lbs. fine-ground Indigo, stirred into a mixture of
8 lbs. Nordhausen, or fuming Oil Vitriol, and
8 lbs. Oil Vitriol, at 66°.
Let stand for several days in a warm place.

38. *Sulphate of Chrome, at 50° B.*

3 lbs. Bichromate of Potash,
$11\frac{1}{2}$ pints of Water are boiled to a paste with
$1\frac{1}{2}$ lbs. Wheat Starch, and to this is added, in small portions at a time, a mixture of
3 lbs. Oil Vitriol, 66°, and $1\frac{1}{2}$ pints of Water. The whole is then to be cooked in an enamelled vessel so long as any escape of gas takes place.

39. *Tin Solution, for Brightening Reds and Pinks.*

Into 10 lbs. Nitric Acid, at 36° B., introduce
10 lbs. Tin Crystals in very small portions at a time, steadily stirring.

40. *Chloride of Soda, 5° B.*

To 5 gallons of a solution of Bleaching Powder, at 7° B., add
7 lbs. Soda Crystals, dissolved in 5 quarts of water. Stir well and let settle.
Gives 24 quarts clear Chloride of Soda.

41. *Acetate of Alumina A., for Aniline Carmine.*

$3\frac{1}{2}$ lbs. Sulphate Alumina,
$3\frac{1}{2}$ quarts Water and
4 lbs. White Sugar of Lead.

42. *Alumina Precipitate for Aniline Colors.*

In 4 quarts of Water, dissolve
4 lbs of Alum, then add
3 lbs. Aqua Ammonia and
2 quarts of Water.
Collect the precipitate, wash and strain.

43. *Pyrolignite of Copper, at 15° B.*

1 gallon of Water,
4 lbs. Blue Vitriol (Sulphate of Copper),
3 lbs. Brown Sugar of Lead. Let settle, and use the clear liquid. If too strong, add water to bring to desired degree.

44. *Acetate of Copper, at 20° B., for Steam Purple.*

3 lbs. Blue Vitriol dissolved in
3 quarts Water,
2 lbs. White Sugar of Lead, dissolved in
1 quart of Water.
Mix the two solutions and let settle.

45. *Acetate of Chrome, at 16° B.*

In 1 gallon of Water, and
12 lbs. Acetic Acid, dissolve
5 lbs. White Sugar of Lead; then add
7 lbs. Sulphate of Chrome, at 42° B.
Let settle, and use the clear liquid.

46. *Chrome Alum.*

2 lbs. Bichromate Potash, dissolved with heat in
5 quarts Water.
When the solution is cooled down to 104° F., add
3 lbs. Oil Vitriol; stir well, and let cool down to 77° F., then stir in 1 pint Alcohol, and set away for the Chrome Alum to crystallize out.

47. *Acetate of Protoxide of Iron, at 20° B.*

5 quarts of Water,
5 lbs. Green Copperas,
7½ lbs. Sugar of Lead.

48. *Tin Solution for Fast Green.*

4 lbs. Tin Crystals, dissolved in
2 lbs. Muriatic Acid, at 22° B.

49. *Tin Solution for Fast Blue.*

10 lbs. Tin Crystals, dissolved in 10 lbs. Muriatic Acid, 22° B.

50. *Oxidized Sapan Liquor, for Steam Orange.*

3½ lbs. Sapan Liquor, at 20° B.,
5 pints Water,
1 ounce Chlorate Potash,
½ ounce Muriatic Acid.

51. *Crimson Lake for Wool.*

8 lbs. Cochineal, cooked with 5 or 6 pints of Water.
To the decoction, stir gradually and constantly in, a solution made of
2 quarts of Water,
2 lbs Tin Crystals,
2½ lbs. Muriate of Tin.

Let settle, draw off the supernatant liquor, wash the precipitate well with water; collect on a strainer, and let drain well.

52. *Indigo Precipitate for Fast Blue and Green.*

10 lbs. Quicklime, slacked with
6½ gallons Water; then
2 lbs. ground Indigo, finely rubbed in Water, are well stirred in; then add
6 lbs. Copperas, dissolved in 5 gallons of Water; then add
5 gallons hot Water and
15 gallons cold Water.

Stir well from time to time until the liquid has assumed a yellow color, and deep blue veins or streaks appear upon its surface. When this moment arrives, draw off the clear liquor and precipitate every 10 quarts of it with

½ lb. Tin Crystals dissolved in ½ lb. Muriatic Acid.

To the remainder of the mixture of Lime and Indigo, 15 gallons of water may be added, and the whole stirred, and when settled the Indigo may be precipitated from the clear liquor as before. This operation may be repeated a second time before all the Indigo is exhausted.

The Indigo precipitate is to be collected on a muslin filter, and well squeezed out.

53. *Chloride of Potash, at 20° B.*

In 6½ lbs. of solution of Bleaching Powder, at 8° B.,
1½ lbs. of Pearlash is to be dissolved.
Let settle, and use the clear liquor.

54. *Chloride of Soda, at 9° B.*

In 6½ lbs. solution Bleaching Powder, at 8° B., dissolve
1½ lbs. Soda Crystals.

55. *Thickening, or British Gum Water.*

2 lbs. light colored British Gum, dissolved in
1 quart of boiling Water.

56. *Gum Water.*

2 lbs. Gum Arabic, dissolved in
1 quart boiling Water.

57. *Dextrine Water.*

2 lbs. Dextrine, dissolved in
1 quart boiling Water.

58. *Leicome Water.*

2 lbs. Leicome, dissolved in
1 quart boiling Water.

59. *Gum Tragacanth Mucilage.*

In 10 quarts of Water, soak
1 lb. of Gum Tragacanth, and then cook it well.

BLACKS.

Black for Block Printing.

13 lbs. Iron Liquor, at 10° B.,
$5\frac{1}{2}$ lbs. Pyrolignite Alumina, at 8° B.,
$1\frac{1}{2}$ oz. Logwood Liquor, at 20° B., to be cooked with
$1\frac{3}{4}$ lbs. Wheat Starch.
When the paste is made, add
3 oz. Olive Oil.

Black thickened with Gum.

2 quarts of Water,
$5\frac{1}{2}$ lbs. Iron Liquor, at 14° B.,
$12\frac{1}{2}$ oz. Acetic Acid at 8° B.,
14 oz. Logwood Liquor at 20° B.,
$4\frac{1}{2}$ lbs. Gum Arabic.

Black thickened with Starch and Flour.

37 quarts Iron Liquor, at 15° B.,
43 quarts Water,
2 quarts Logwood Liquor, at 2° B.,
$9\frac{1}{2}$ lbs. Wheat Starch,
$9\frac{1}{2}$ lbs. Wheat Flour,
$1\frac{1}{2}$ pints Olive Oil.

Black thickened with Starch.

$12\frac{3}{4}$ lbs.	Prepared Iron Liquor,
$2\frac{1}{2}$ pints	Water,
18 oz.	Logwood Liquor, at 20° B.,
$2\frac{3}{4}$ lbs.	Wheat Starch,
$2\frac{3}{4}$ lbs.	British Gum.

Topical Black well suited for raising in Alizarine.

11 oz. of	Starch,
11 oz. of	British Gum,
4 lbs. 6 oz.	Logwood Liquor, at 20° B.,
1 lb.	Decoction of Galls, 20° B.,
$3\frac{3}{4}$ lbs.	Iron Liquor, 14° B.,
2 lbs.	Acetic Acid, 8° B.,
$1\frac{1}{2}$ oz.	Yellow Prussiate of Potash,
$\frac{1}{3}$ oz.	Chlorate of Potash,

are well cooked together. After cooling, and immediately before using, add 14 oz. Nitrate of Iron, at 36° B.

Topical Black suitable for raising either in Alizarine or Garancine.

5 lbs.	Logwood Liquor, at 20° B.,
$5\frac{1}{2}$ lbs.	Acetic Acid, at 8° B.,
$1\frac{3}{4}$ lbs.	Starch,
$7\frac{3}{4}$ lbs.	Iron Liquor, at 10° B.,
1 lb. 3 oz.	Oil.

Topical Black.

1 lb. 3 oz.	Logwood Liquor, at 20° B.,
$3\frac{1}{2}$ lbs.	Wheat Starch,
15 pints	Water,
$\frac{3}{4}$ lb.	Acetate of Iron, 10° B.,
7 oz.	Acetate Alumina, 15° B.,
5 oz.	Lard.

Steam Black.

$13\frac{1}{2}$ lbs.	Oxidized Logwood Liquor, 6° B.,
2 lbs.	Wheat Starch,
$2\frac{3}{4}$ lbs.	British Gum,
2 lbs.	Red Prussiate,
10 oz.	Prussiate of Tin,
1 lb.	Tartaric Acid,
1 oz.	Nitrate of Iron, at 50° B.

Steam Black.

10 lbs.	Logwood Liquor, at 20° B.,
$2\frac{1}{4}$ lbs.	Acetate Alumina, 10° B.,
$2\frac{1}{4}$ lbs.	Acetic Acid, 8° B.,
2 lbs. 6 oz.	Iron Liquor, 14° B.,
9 oz.	Oil, thickened with $5\frac{1}{2}$ lbs. Gum Arabic.

Steam Black thickened with Starch.

$9\frac{1}{4}$ lbs.	Logwood Liquor, at 20° B.,
$2\frac{1}{4}$ lbs.	Acetate Alumina, 10° B.,
$2\frac{1}{4}$ lbs.	Acetic Acid, 8° B.,
2 lbs. 6 oz.	Iron Liquor, 14° B.,
9 oz.	Oil, cooked with
$2\frac{3}{4}$ lbs.	Wheat Starch.

Topical Black.

$3\frac{1}{4}$ lbs.	Flour,
$13\frac{3}{4}$ lbs.	Logwood Liquor, 6° B.,
7 lbs. 6 oz.	Iron Liquor, 14° B.,
$2\frac{1}{2}$ lbs.	Acetic Acid, 8° B.

Steam Black.

3 lbs. 2 oz.	Wheat Starch,
$6\frac{1}{4}$ lbs.	Acetic Acid, at 8° B.,
5 lbs.	Logwood Liquor, 20° B.,
1 lb.	Yellow Wood (Fustic) Liquor, 20° B.

Cook, and when the paste is made, add, in small portions at a time, a solution made of

½ lb.	Bichromate Potash,
2 lbs. 10 oz.	Acetic Acid, 8° B., and
1¼ lbs.	Muriatic Acid.

Stir well, and thicken the color with an addition of

2 lbs. 2 oz. British Gum.

Steam Black, which must be passed, after steaming, through a bath of Chrome, to develop its full intensity.

5 lbs.	Logwood Liquor, at 20° B.,
5½ lbs.	Acetic Acid, 8° B.,
2 lbs. 3 oz.	Wheat Starch,
¾ lb.	Leicome,
1 quart	Water,
2 lbs. 9 oz.	Acetate Alumina, 11° B.,
2 lbs. 9 oz.	Iron Liquor, 14° B.,
5½ oz.	Lard,
5½ oz.	Oil of Turpentine.

Steam Black which stands Soap-bath.

6 lbs.	British Gum,
8 lbs.	Logwood Liquor, at 10° B.,
2½ pints	Water,
1¼ lbs.	Acetic Acid, at 8° B. Cook, then add
8 lbs.	Acetate of Chrome, 17° B.,
10½ oz.	Chlorate Potash, dissolved in
3 gills	Water.

Aniline Black, with Chloride of Aniline.

In 3 lbs. Starch paste (5 ounces of Starch to the quart water),
3 lbs. Tragacanth Mucilage (3 oz. Tragacanth to 1 quart water),
3 lbs. British Gum Water (13 oz. gum to 1 quart water),
3 oz. Chlorate Potash are dissolved.

When the mixture is cold, dissolve in it

½ lb. Chloride of Aniline, and, just before using, add the necessary

2¾ oz. Sulphuret of Copper.

Aniline Black, with Oxalate of Aniline.

3 lbs. Starch paste, as in preceding,
3 lbs. Tragacanth Mucilage, do.
3 oz. British Gum Water, do.
2 oz. Chlorate Potash,
4 oz. Chloride Calcium (Muriate Lime), well cooked. After cooling, add
6 oz. Oxalate of Aniline,
¾ oz. Sal-Ammoniac,
2 oz. Sulphuret of Copper.

Aniline Black, with Tartrate of Aniline.

18 lbs. Wheat Starch,
18 lbs. British Gum,
12 gallons Water,
16 lbs. Aniline Oil,
10 oz. Chlorate Potash,
10 oz. Sal-Ammoniac, all well cooked together, and just before using, add, for every quart of the above mixture,
2 oz. Sulphuret Copper, in paste, and
5 oz. Tartaric Acid, dissolved in
2 gills Water.

[The cloths must not be dried with great heat. It is better to take them from the place of drying a little damp than go to the other extreme. Their oxidation is complete in 24 hours, if aerated at about 86° F. in a moist atmosphere. They may be cleansed by a passage in hot water, rendered slightly alkaline with Soda Crystals, and the cleansing is completed in a boiling soap-bath. S. B.]

Aniline Black, with Tungstate of Chrome.

2 quarts Water,
9 oz. Wheat Starch,
13 oz. Tungstate of Chrome, in form of paste. This is made by precipitating Chloride of Chrome with Tungstate of Ammonia.

To the above mixture, while still lukewarm, add
2 oz. Chlorate Potash,
1 oz. Sal-Ammoniac,
¼ lb. Chloride of Aniline.

Aniline Black, with Tungstate of Chrome.

No. 1.

4 kilos. Wheat Starch,
22 litres Water,
5 kilos. Tungstate of Chrome.
Cook half an hour, and add
4 kilos. 500 gr. British Gum,
1 kilo. 100 gr. Chlorate Potash,
550 gr. Sal-Ammoniac.

No. 2.

1 kilo. 500 gr. Wheat Starch,
8 litres Water,
3 kilos. Chloride of Aniline.

At time of application, stir No. 2 into No. 1, while cold. (French Receipts.) S. B.

N. B. The usual proportions are 2 parts No. 1, to 1 part No. 2. Oxidize the printed cloth at 86° Fahr., with very little humidity. Afterwards steam ½ hour.

Sulphuret of Copper in Paste, for Aniline Black.

In 12 lbs. Solution of Caustic Soda, at 38° B.,
2 lbs. 3 oz. Flour of Sulphur are dissolved by means of

heat. When the solution is complete, add to the liquor

10½ lbs. Blue Vitriol, dissolved in
20 gallons Water. Stir well, and filter.
The precipitate is well washed on the filter, and employed in the form of a paste.

Steam Black for Half-Wool.

14 oz.	Wheat Starch and
4 lbs. 6 oz.	Leicome are well cooked in
1 lb.	Indigo paste,
7¾ lbs.	Logwood Liquor, 20° B.,
7¾ lbs.	Pyrolignite of Iron.

Steam Black for Half-Wool.

5 lbs.	Leicome,
5¼ lbs.	Logwood Liquor, 20° B.,
4 lbs. 10 oz.	Iron Liquor, 14° B.,
1 lb.	Pyroligneous Acid,
14 oz.	Indigo paste, and
3 lbs. 5 oz.	Quercitron Liquor, 20 B.,

are cooked together, and to the mixture, when cold, is added

1½ lbs.	Nitrate Iron, at 20° B., and
5 oz.	Chlorate of Potash.

Steam Black for Wool.

4 lbs.	Leicome,
7 lbs.	Logwood Liquor, at 20° B.,
1¼ lbs.	Indigo paste,
2½ lbs.	Copperas,
5¼ lbs.	Acetic Acid.

Steam Black for Wool.

¾ lbs.	Wheat Starch,
8¾ lbs.	Iron Liquor, 14° B.,

3 lbs. 3 oz. Archil Extract, 10° B.,
$\frac{3}{4}$ lbs. Quercitron Liquor, 20° B.,
$\frac{3}{4}$ lbs. Indigo paste,
4 lbs. 6 oz. Logwood Liquor, 20° B.,
$3\frac{1}{4}$ lbs. Leicome.

CHOCOLATES.

The Brown Colors derived from Madder, which are generally called *Chocolates* in the Print-Works, depend for their depth of tone, which is developed in the raising, on a variable mixture of Acetate of Alumina and Pyrolignite of Iron; on the thickening and dyeing.

The mixtures are designated by numbers, as 1, 6, 30, and so on; and these numbers signify how many parts of Acetate of Alumina are to be used with one part of Iron Liquor, to produce the shade desired; thus, 8° Chocolate 1, signifies that one part of Acetate of Alumina at 8° is to be used with one part of Iron Liquor at 8°; 8° Chocolate 6, signifies that six parts of Acetate Alumina at 8° is to be used with one part of Iron Liquor at the same degree; and so on.

A convenient formula for all shades of Chocolate is as follows: In this formula, n signifies, as in the preceding paragraph, how many parts of Acetate of Alumina are to be used with one part of Iron Liquor.

$\frac{15\,n}{n+1}$ lbs. Acetate of Alumina, at X° B.,
$\frac{15}{n+1}$ lbs. Iron Liquor, at X° B.,
$2\frac{1}{4}$ lbs. British Gum,
$2\frac{1}{4}$ lbs. Wheat Starch,
$1\frac{1}{8}$ oz. Logwood Extract, at 20° B.,
$2\frac{1}{4}$ oz. Oil of Turpentine.

8° Chocolate 1.

$7\frac{1}{2}$ lbs. Acetate of Alumina, at 8° B.,
$7\frac{1}{2}$ lbs. Iron Liquor, at 8° B.,

$2\frac{1}{4}$ lbs. British Gum,
$2\frac{1}{4}$ lbs. Wheat Starch,
$1\frac{1}{8}$ oz. Logwood Liquor, 20° B.,
$2\frac{1}{4}$ oz. Oil of Turpentine.
This gives rather a dark Chocolate.

8° Chocolate 6.

12 lbs. Acetate Alumina, at 8° B.,
2 lbs. Iron Liquor, at 8° B.,
$2\frac{1}{4}$ lbs. British Gum,
$2\frac{1}{4}$ lbs. Wheat Starch,
$1\frac{1}{8}$ oz. Logwood Liquor, 20° B.,
$2\frac{1}{4}$ oz. Oil of Turpentine.
This is a lighter Chocolate.

8° Chocolate 30.

15 lbs. Acetate Alumina, at 8° B.,
$\frac{1}{2}$ lb. Iron Liquor, at 8° B.,
$2\frac{1}{4}$ lbs. British Gum,
$2\frac{1}{4}$ lbs. Wheat Starch,
$1\frac{1}{8}$ oz. Logwood Liquor, at 20° B.,
$2\frac{1}{4}$ oz. Oil of Turpentine.
This gives a very light Chocolate.

Steam Chocolate on unprepared Cotton.

$7\frac{1}{2}$ lbs. Steam Chocolate Preparation, No. 1,
$1\frac{1}{4}$ lbs. Persian Berries,
$1\frac{1}{4}$ lbs. Logwood Liquor, at 7° B.,
$4\frac{1}{2}$ oz. Sulphate of Copper,
2 lbs. 3 oz. Gum Senegal.

Steam Chocolate Preparation, No. 1.

23 lbs. Brazil-wood Liquor (Sapan or Lima),
$2\frac{3}{4}$ lbs. Alum,
2 lbs. 3 oz. Sugar of Lead. Let settle, and use the clear liquor.

Steam Chocolate on unprepared Cotton.

25 lbs. Steam Chocolate Preparation, No. 2,
3¼ lbs. Starch,
5½ oz. Chlorate Potash,
5½ oz. Muriatic Acid.

Steam Chocolate Preparation, No. 2.

15¾ lbs.	Sapan Liquor, at 9° B.,
3¾ lbs.	Quercitron Liquor, 8° B.,
1 gallon	Water,
9¼ lbs.	Logwood Liquor, 4° B.,
3¼ lbs.	Sulphate Alumina,
4 lbs. 6 oz.	Brown Sugar of Lead.

Steam Chocolate on Goods prepared with Stannate of Soda.

4½ lbs. Wheat Starch,
5 pints Water,
10 lbs. Logwood Liquor, 10° B.,
5¼ lbs. Caustic Soda Lye, at 10° B.,
are well cooked together. When cooled, add
3 oz. Red Prussiate Potash.

Steam Chocolate on prepared Goods.

4¾ lbs.	Oxidized Logwood Liquor,
7 lbs.	Oxidized Brazil-wood Liquor,
2 lbs. 9 oz.	Quercitron Liquor, 20° B.,
2½ lbs.	Nitrate Alumina, 17° B.,
1¼ lbs.	Steam Chocolate Preparation, No. 3,
1¾ lbs.	Wheat Starch,
½ lb.	Leicome, and
2½ oz.	Alum, are well cooked together.

Oxidized Logwood Liquor.

4¾ lbs. Logwood Liquor, at 10° B.,
1¼ oz. Chlorate Potash,
½ oz. Muriatic Acid. Cook 5 minutes.

Oxidized Brazil-wood Liquor.

7 lbs. Sapan or Lima-wood Liquor, at 8° B.,
2¼ oz. Chlorate Potash,
½ oz. Muriatic Acid. Cook 5 minutes.

Steam Chocolate Preparation, No. 3.

In 6¾ lbs. Sapan Liquor, at 3° B.,
1 lb. 10 oz. Quercitron Liquor, 5° B., dissolve
3½ oz. Alum,
3¼ oz. Sugar of Lead,
½ oz. Sal-Ammoniac. Use the clear liquor after settling.

Steam Chocolate on prepared Goods.

3¾ pints Water,
4 lbs. Acetate Alumina, 15° B.,
4¼ lbs. Logwood Liquor, 20° B.,
1 lb. Starch,
4½ lbs. British Gum are cooked together. Then dissolve in it
6 oz. Sal-Ammoniac,
2 oz. Oxalic Acid. When quite cold, add
3 lbs. 14 oz. Steam Blue Preparation for Chocolates. See No. 14, Mordants.

Steam Chocolate for Goods prepared or unprepared.

2 lbs. Logwood Liquor, at 10° B.,
1¾ lbs. Sapan Liquor, 10° B.,
¾ lb. Quercitron Liquor, 10° B.,
1¾ lbs. Acetate Alumina, 11° B.,
1 lb. Wheat Starch,
2 lbs. Tragacanth Mucilage (2 oz. Tragacanth to 1 quart water). Cook together, and, when cold, add
4½ oz. Acetate Copper, 18° B.

Steam Chocolate.

4 lbs. Brazil-wood Liquor, 20° B.,
1¼ lbs. Yellow Wood (Cuba) Liquor, 20° B. (Fustic Liquor),
6 lbs. Acetate Chrome, 16° B.,
7 pints Water, cooked with
1 lb. Starch,
½ lb. British Gum.

Chocolate to be passed through a Chrome Bath.

8 lbs. Sapan Liquor, 20° B.,
3¼ lbs. Yellow Wood Liquor, 20° B. (Fustic Liquor),
3½ lbs. Acetate Alumina, 11° B., and
5 lbs. Gum Arabic.

Steam Chocolate on Wool.

2½ lbs. Wheat Starch,
5 pints Water,
12 lbs. Archil Extract, 10° B.,
5½ oz. Indigo Paste,
½ lb. Alum.

Steam Chocolate on Wool.

12¼ lbs. Archil Extract, 10° B.,
½ lb. Wheat Starch,
1½ lbs. British Gum,
1 lb. 14 oz. Indigo Paste,
11 oz. Alum,
1½ lbs. Logwood Liquor, at 20° B.,
1½ lbs. Yellow Wood Liquor, 20° B. (Fustic Liquor).

Steam Chocolate on Wool.

15 lbs. Archil Extract, 12° B.,
4 lbs. Leicome,
11 oz. Indigo Paste,
½ lb. Alum.

REDS.

The following Reds may be raised in the same beck with Roses, or by themselves alone, either with Madder or Flowers, soaped and brightened.

Deep Red for Cotton Goods.

2	lbs.	Wheat Starch,
25	lbs.	Red Preparation (see next below),
3½	ounces	Logwood Liquor, 20° B.,
3½	ounces	Olive Oil, cooked well together.

Red Preparation.

21	pints	Water,
6	lbs. 5 oz.	Sugar of Lead,
6	lbs. 5 oz.	Alum,
1¾	lbs.	Pyroligneous Acid, 2° B.,
3	lbs. 5 oz.	Nitrate Zinc, 40° B.

Deep Red.

7	lbs.	Acetate Alumina, at 11° B.,
1¼	lbs.	Starch,
4	ounces	Sapan Liquor, 20° B.,
2	lbs. 6 oz.	Nitrate Zinc, 15° B.,
1	ounce	Olive Oil, cooked well together.

Standard No. 1, for Resist Red.

2	lbs.	Wheat Starch,
25	lbs.	Red Preparation (see above),
14	ounces	Quercitron Liquor, 20° B.,
3½	ounces	Olive Oil.

Resist Red, ½.*

1 quart of Standard No. 1, sharpened with
½ ounce Tin Crystals,
½ ounce Acetic Acid, 8° B.

Resist Red, 2.

1 quart of Standard No. 1,
2 ounces Tin Crystals,
2 ounces Acetic Acid, 8° B.

Resist Red, 4.

1 quart of Standard No. 1,
4 ounces Tin Crystals,
4 ounces Acetic Acid, 8° B.

Standard No. 2, for Resist Reds thickened with British Gum.

4¾ lbs.	Pyrolignite Alumina, 11° B.,
3½ ounces	Nitrate Zinc, 20° B.,
3¾ ounces	Brazil wood Liquor, 20° B.,
1 ounce	Oil Turpentine,
2 lbs. 3 oz.	British Gum.

Red without Nitrate of Zinc.

18½ lbs.	Pyrolignite Alumina, 11° B.,
3 lbs. 2 oz.	Wheat Starch,
10 oz.	Brazil-wood Liquor, 20° B.

Steam Red No. 1, on prepared Cotton.

9 lbs. 10 oz.	Sapan Liquor, 20° B.,
1½ lbs.	Quercitron Liquor, 20° B.,
10 oz.	Red Prussiate Potash,
1 gallon	Gum Water, 1 lb. to the quart,
½ lb.	Acetate Alumina, at 15° B.

* The figures following the words "Resist Red," signify the number of ounces of Tin Crystals and Acetic Acid to be added to one quart of the Standard.

Steam-Scarlet Red on prepared Goods.

$16\frac{1}{4}$ lbs.	Cochineal Extract, 14° B.,
15 oz.	Quercitron Extract, 20° B.,
2 lbs. 6 oz.	Wheat Starch. Cook.
When cold, add	
13 oz.	Salts Sorrel (Binoxalate Potash),
1 lb. 9 oz.	Tin Composition for Scarlet, No. 26 Preparation.

Steam Red No. 2, on prepared Goods.

$1\frac{1}{2}$ pints	Water,
5 lbs. 10 oz.	Acetate Alumina, 15° B.,
5 lbs.	Sapan Liquor, 20° B.,
$5\frac{1}{2}$ lbs.	British Gum,
$5\frac{3}{4}$ oz.	Sal-Ammoniac,
$2\frac{1}{2}$ oz.	Oxalic Acid,
4 lbs.	Blue Standard, No. 14 Mordant.

Steam Red on prepared Cotton.

11 lbs.	Sapan Extract, 14° B.,
1 lb. 2 oz.	Persian Berry decoction, 7° B.,
1 lb. 10 oz.	Sulphate Alumina,
2 oz.	Chlorate Potash,
$3\frac{1}{4}$ lbs.	Gum Arabic.

Steam Scarlet on Wool.

11 lbs.	Cochineal Lake,
2 quarts	Water,
$5\frac{1}{2}$ lbs.	Gum Arabic,
9 oz.	Salts Sorrel. Cook, and, when cold, add
9 oz.	Oxalic Acid.

PINKS.

These colors are raised in Madder or Flowers, and are made with a solution of Pyrolignite or Acetate of Alumina, thickened with British Gum.

Pink 4.

1 lb. Pyrolignite Alumina, at 11° B.,
4 lbs. British Gum Solution for Roses.

Pink 20.

1 lb. Pyrolignite Alumina, 11° B.,
20 lbs. British Gum Solution for Roses.

British Gum Solution for Roses.

9 lbs. 3 oz. British Gum,
11 pints Water,
1¼ lbs. Nitrate of Zinc, 50° B.

Steam Rose on Prepared Cotton.

11 lbs. 13 oz. Cochineal Decoction, 5° B.,
3 lbs. 3 oz. Acetate Alumina, 15° B.,
1¼ lbs. Solution Tartaric Acid, 20° B.,
3½ lbs. Powdered Gum Arabic.
The same may be thickened with 1½ lbs. Wheat Starch in place of the Gum Arabic.

Steam Pinks.

Steam Reds No. 1 and No. 2 may be diluted with Gum Water; 1 part of Red to 4 parts Gum Water to produce Pinks.

Topical Rose on Cotton.

3 lbs. Tragacanth Mucilage (1½ oz. to the quart),
2 quarts Water,
4¼ lbs. Sapan Liquor, 10° B.,

1 lb. 5 oz. Acetic Acid, 8° B.,
17½ oz. Pink Salts,
2 oz. Chloride of Copper, 40° B.

Topical Rose on Cotton.

4 quarts Water,
9½ lbs. Sapan Liquor, 10° B.,
11 lbs. Tragacanth Mucilage,
3 lbs. 6 oz. Sal-Ammoniac,
3½ lbs. Muriate Tin, 55° B.,
11 oz. Nitrate Copper, 55° B.

Steam Rose on prepared Cotton.

4 lbs. 2 oz. Cochineal Decoction, 8° B.,
2½ pints Water,
4 oz. Alum,
2 oz. Cream Tartar,
⅓ oz. Oxalic Acid.
2 lbs. 10 oz. Gum Arabic.

Steam Aniline Rose on Cotton.

3½ oz. Fuchsine in Crystals. Dissolve in
1 pint Alcohol. Stir in
17 oz. Tragacanth Mucilage, and add finally
12½ lbs. Solution Blood Albumen (21 ounces to the quart).

Dark Aniline Rose on unprepared Cotton.

2 lbs. Fuchsine Carmine,
14½ lbs. Acetate Alumina,
17½ lbs. Gum Water.

Aniline Rose on unprepared Cotton.

3 lbs. Wheat Starch,
4 quarts Water,
7¼ lbs. Acetate Alumina, well cooked together.

Then add a mixture of
4 lbs. 6 oz. Fuchsine Carmine,
4 lbs. 6 oz. Acetate Alumina.

Aniline Rose.

4 oz. Fuchsine in Crystals,
1 quart Water,
1 quart Glycerine. Cook 15 minutes.
Thicken with 1½ lbs. Gum Arabic.
When completely cold, add
14 lbs. Albumen Solution (2 lbs. Egg Albumen to 1 quart Water).

Aniline Rose.

5 lbs. Solution Fuchsine in Alcohol, No. 1,
8 lbs. Gum Water.
Heat, until 3 lbs. are steamed away. When completely cold, add
5 lbs. Albumen Solution (2 lbs. Egg Albumen to 1 quart Water).

Fuchsine Rose.

2 lbs. Solution of Caseine,
½ lb. Fuchsine Solution in Alcohol, No. 1.

Caseine Solution.

2 lbs. Caseine,
3 quarts Water,
6¼ oz. Liquid Ammonia.

Coralline Rose.

½ lb. Coralline. Dissolve in
2½ pints Alcohol, and thicken with
9 lbs. Caseine Solution.

Rose on Wool.

9½ lbs. Scarlet Lake,
9½ lbs. Gum Water,
1 lb. Oxalic Acid.

Aniline Rose on Wool.

6 lbs. Fuchsine Solution, No. 2, thickened with
10 lbs. Gum Water.

Fuchsine Solution, No. 1.

3½ oz. Fuchsine dissolved with heat in
4 quarts Alcohol.

Fuchsine Solution, No. 2.

1 lb. Fuchsine in Crystals, dissolved in
8 lbs. Acetic Acid, 8° B.

Caseine Solution.

2 lbs. Caseine powdered,
2½ oz. Calcined Magnesia,
1 gallon Water.

Stir the Caseine and Magnesia, each by itself, in a little of the Water. Then mix both with the rest of the Water. Stir till it thickens, and let rest over night.

Then add a solution of 10 ounces crystallized Baryta hydrate in 3 quarts of warm Water at not over 95° Fahr.

This will form a gum-like solution, having the properties of Egg Albumen, at a moderate price. The cost for materials in France is about 50 cents per gallon.

PURPLES.

Purples are formed by mixtures of Acetate of Iron and solution of British Gum, cooked together. The shades are darker when Wheat Starch is used in place of British Gum. The figure which follows the word Purple, signifies how many pounds of British Gum Solution are to be used for one pound of Acetate of Iron. Thus

Purple 8.

Consists of 1 lb. Acetate of Iron, at 11° B.,
8 lbs. Solution British Gum.

Purple 40.

1 lb. Acetate of Iron, at 11° B.,
40 lbs. British Gum Solution.

Purple for Hair Lines.

2 lbs. 7 oz.	Acetate of Iron, 10° B.,
5¾ lbs.	Gum Arabic,
2¼ lbs.	Pyroligneous Acid, 2° B.,
11 pints	Water,
2 oz.	Logwood Liquor, 20° B.

Steam Purple on Cotton prepared with Stannate of Soda.

9 lbs. 6 oz.	Logwood Liquor, 2½° B.,
4½ oz.	Sal-Ammoniac,
1 lb. 2 oz.	Lemon Juice, 27° B.,
16 lbs.	Gum Water,
10½ oz.	Oxide of Tin (*vide* No. 24),
5¼ oz.	Nitrate Copper, 55° B.

Steam Purple on prepared Cotton.

5¾ lbs.	Logwood Liquor, 4° B.,
1½ oz.	Lemon Juice, 27° B.,
4½ oz.	Red Prussiate Potash,
1 lb. 5 oz.	Gum Arabic.

Steam Purple on unprepared Cotton.

3½ lbs.	Standard R. (see next page),
2 lbs. 14 oz.	Gum Water,
1 lb. 3 oz.	Acetate Alumina, 12° B.

Standard R.

5 lbs. Steam Purple Preparation (see below),
2 lbs. Gum Arabic,
1½ oz. Acetate Copper, 20° B.

Steam Purple Preparation.

4¾ lbs. Acetate Alumina, 12° B.,
17½ oz. Ground Logwood,
9½ oz. Logwood Liquor, 20° B.,
Heat to 190° F. Use the clear liquor.

Topical Purple on Cotton.

2 lbs.	Logwood Liquor, 6° B.,
2 quarts	Water,
6 lbs.	Gum Water (1½ lbs. to the quart),
9 oz.	Sal-Ammoniac,
3 oz.	Alum,
1½ oz.	Oxalic Acid,
1½ oz.	Nitrate Copper, 8° B.,
¾ lb.	Muriate Tin, 60° B.

Topical Purple.

10 lbs.	Logwood Liquor, 5½ B.,
13 oz.	Sal-Ammoniac,
5¾ oz.	Sulphate Copper,
3½ oz.	Oxalic Acid,
2 lbs. 6 oz.	Pink Salts,
6¼ lbs.	Gum Water.

Steam Aniline Purple on Cotton.

1½ oz. Aniline Purple (Paris Purple, Dahlia) are dissolved in
2 pints Alcohol, and then Gum Water added. The mix-

ture is now heated until 1 pint is steamed off. Let cool. When fully cold, add 10 lbs. Albumen Solution (2 lbs. Egg Albumen or 1 lb. Blood Albumen to the quart of Water).

Steam Aniline Purple on prepared Cotton.

$1\frac{3}{4}$ lbs. Aniline Purple in paste,
11 lbs. Acetic Acid, 8° B.,
$3\frac{1}{2}$ oz. Tannin,
$1\frac{1}{2}$ lbs. Wheat Starch,
3 quarts Water.

Steam Purple on unprepared Cotton.

2 lbs. Purple Carmine (of R. Knosp in Stutgard),
6 lbs. Acetate Alumina, at 8° B.,
8 lbs. Gum Water (2 lbs. to the quart).

Steam Aniline Purple.

$2\frac{1}{2}$ lbs. Wheat Starch,
$4\frac{1}{2}$ quarts Water,
6 lbs. Acetate Alumina, A.,
3 lbs. Aniline Purple Carmine,
2 lbs. Acetic Acid.

Aniline Purple on Wool.

1 lb. 13 oz. Aniline Purple in paste,
2 pints Alcohol,
14 lbs. Gum Water,
1 quart Water.

Aniline Purple on Wool.

$2\frac{1}{2}$ oz. Aniline Purple (Paris Purple, Dahlia),
8 lbs. Acetic Acid, 8° B. Dissolve with warming, and thicken with 10 lbs. Gum Water.

BLUES.

Fast Blue on Cotton.

10½ oz.	fine-ground Indigo, rubbed up with
1 lb. 3 oz.	Caustic Soda Solution, 20° B., and added to
4 lbs. 13 oz.	Caustic Soda Solution, 20° B., and
11 oz.	Red Sulphuret Arsenic (Realgar).

Cook the whole ½ hour, and thicken with

2 lbs.	Gum Arabic.

Fast Blue on Cotton.

9 lbs. 2 oz.	Indigo Precipitate, No. 52,
1½ lbs.	Nitrate Protoxide of Iron, 32° B.,
11¼ lbs.	Gum Water (2 lbs. Gum Arabic to 1 quart Water).

Fast Blue on Cotton.

4 lbs.	Indigo Precipitate, No. 52.
6 lbs.	British Gum Water (2 lbs. B. Gum to 1 quart Water),
4¼ lbs.	Nitrate Protoxide Iron, 14° B.

The Nitrate of Iron may be replaced by 4½ lbs. Chloride of Iron, at 28° B.

Fast Blue on Cotton.

24 lbs.	Indigo Precipitate,
8 lbs.	Nitrate Protoxide Iron, 32° B.,
24 lbs.	Gum Water.

Steam Blue on prepared Cotton Goods.

4 quarts	Water,
2 lbs.	Starch. Cook to a paste, and add
2½ lbs.	Yellow Prussiate,
13½ oz.	Tartaric Acid,
7 oz.	Sal-Ammoniac,
4 lbs. 3 oz.	Prussiate Tin.

Steam Blue on prepared Goods.

9 pints	boiling Water,
1 lb.	Sal-Ammoniac,
1 lb. 6. oz.	Yellow Prussiate Potash,
$10\frac{1}{2}$ oz.	Red Prussiate Potash,
4 lbs. 2 oz.	Prussiate Tin,
5 lbs.	Gum Arabic.

Steam Blue on prepared Goods.

$1\frac{3}{4}$ lbs.	Starch, cooked with 9 pints water; add
$1\frac{3}{4}$ lbs.	Yellow Prussiate. In another vessel dissolve
$1\frac{3}{4}$ lbs.	Tartaric Acid and 3 oz. Oxalic Acid in
$1\frac{1}{2}$ pints	Water, and mix the two. Finally, add to the mixture
4 lbs.	Prussiate Tin,
11 oz.	Brazil-wood Liquor, 6° B.,
$\frac{1}{2}$ oz.	Oil Vitriol.

Steam Blue on prepared Goods, without Tartaric Acid.

2 quarts	Water, cooked with 1 lb. 6 oz. Starch,
$4\frac{1}{2}$ oz.	Alum,
$2\frac{1}{4}$ oz.	Oxalic Acid,
$17\frac{1}{2}$ oz.	Prussiate Tin,
2 lbs. 3 oz.	Yellow Prussiate,
$17\frac{1}{2}$ oz.	Glauber Salts. When completely cold add
13 oz.	Oil Vitriol, 66°, in
$1\frac{1}{2}$ pints	Water.

Steam Blue on prepared Cotton.

6 gallons Water, cooked with $7\frac{1}{4}$ lbs. Starch.
Into the hot paste stir

49 lbs.	Prussiate Tin,
1 lb. 3 oz.	Sal-Ammoniac,
12 lbs. 5 oz.	Yellow Prussiate,

7 lbs. 6 oz. Red Prussiate. When solution is complete, add finally
19 lbs. 11 oz. Tartaric Acid,
1 lb. 13 oz. Oxalic Acid. Stir well in.

Steam Blue on prepared Goods.

15 quarts Water, cooked with 9 lbs. Starch; add
10 oz. Sal-Ammoniac,
24 lbs. Tartaric Acid,
1½ lbs. Oxalic Acid,
2 quarts Water,
18 lbs. Yellow Prussiate,
6 lbs. Red Prussiate,
32 lbs. Prussiate Tin.

Steam Blue on prepared Goods.

2 lbs. Starch, and 1 lb. 3 oz. Tragacanth Mucilage,
7 pints Water, cooked together. To the hot paste, add
2½ lbs. Yellow Prussiate,
2 lbs. Red Prussiate,
7½ lbs. Prussiate Tin.
After the solution has taken place, add
2 quarts Water,
4 lbs. Tartaric Acid,
10 oz. Oxalic Acid,
4½ oz. Oil Vitriol, mixed with
4½ oz. Water.

Ultramarine Blue on Cotton.

3¼ lbs. Ultramarine, 3 F.,
11½ lbs. Blood Albumen Solution,
4 lbs. Tragacanth Mucilage (¾ oz. to the quart),
1¼ lbs. Common Salt.

Ultramarine Blue (dark).

$5\frac{3}{4}$ lbs.	Ultramarine, 3 F.,
$2\frac{3}{4}$ pints	Water,
7 lbs. 5 oz.	Egg Albumen Solution (1 lb. to the quart),
$5\frac{3}{4}$ lbs.	Gum Water.

Ultramarine Blue.

5 lbs. 7 oz.	Ultramarine (superfine),
$2\frac{1}{2}$ pints	Water,
6 lbs. 14 oz.	Egg Albumen Solution (1 lb. to the quart),
$5\frac{1}{2}$ lbs.	Gum Water,
$1\frac{1}{2}$ lbs.	Glycerine.

Aniline Blue on unprepared Cotton.

$3\frac{1}{2}$ lbs.	Aniline Blue Carmine (Knosp's),
6 lbs. 9 oz.	Acetate Alumina A., and
$16\frac{1}{2}$ lbs.	Starch paste ($5\frac{1}{2}$ oz. to the quart water).

Aniline Blue thickened with Gum.

5 oz.	Aniline Blue Carmine,
$9\frac{1}{2}$ oz.	Acetate Alumina,
2 lbs.	Gum Water.

The pieces printed with Aniline Blue Carmine are steamed like other steam colors and washed, and then, in order to remove a reddish tinge which sticks to the blue, are passed for half an hour through a soap-bath, heated to 140° F.

Steam Blue on Wool.

1 lb.	Starch, cooked in 11 pints Water.
To the hot paste add	
$1\frac{3}{4}$ lbs.	Tartaric Acid,
5 oz.	Alum,
3 oz.	Oxalic Acid. When dissolved, add
$1\frac{1}{2}$ lbs.	Red Prussiate,
4 lbs. 10 oz.	Prussiate of Tin.

Sky-Blue on Wool.

1 lb. 2 oz.	fine Indigo paste,
7 oz.	Alum,
$2\frac{1}{2}$ oz.	Oxalic Acid,
13 pints	Water,
$5\frac{3}{4}$ lbs.	Gum Arabic.

Aniline Blue on Wool.

$1\frac{1}{2}$ oz. Aniline Blue (in powder) dissolved in
2 pints Alcohol, with heat. Add then
1 pint Water, filter, and thicken with
12 pints Gum Water.

GREENS.

Fast Green on Cotton (dark).

4 quarts	Water,
26 lbs.	Indigo Precipitate, No. 52,
1 lb.	Sugar of Lead,
4 lbs.	Nitrate of Lead,
3 lbs.	Starch,
5 lbs. 3 oz.	British Gum,
$9\frac{1}{2}$ oz.	Oil Turpentine.

Fast Green on Cotton (light).

38 lbs.	Gum Water,
4 lbs.	Nitrate Lead,
2 lbs.	Sugar of Lead,
7 pints	boiling Water,
8 lbs.	Indigo Precipitate,
2 lbs.	Tin Solution for Fast Green, No. 48.

Dark Steam Green, on prepared Cotton.

7¾ lbs.	Persian Berry Decoction, 10° B.,
3 gills	Water,
1 lb. 7 oz.	Starch. Then add
2 lbs. 7 oz.	Yellow Prussiate,
13 oz.	Red Prussiate,
4 lbs.	Prussiate of Tin,
6½ oz.	Sal-Ammoniac,
3 lbs. 2 oz.	Tartaric Acid,
2½ oz.	Oxalic Acid,
13 oz.	Alum.

Steam Green on prepared Goods.

6 lbs.	Tragacanth Mucilage, (½ oz. to the quart),
7 lbs. 5 oz.	Pyrolignite Alumina, 11° B.,
4 lbs.	Persian Berries Extract, 7° B.,
5 oz.	Tartaric Acid,
6½ oz.	Oxalic Acid,
2 lbs. 1½ oz.	Yellow Prussiate Potash.

Guignet Green on Cotton.

9 lbs. 3 oz.	Guignet Green in paste,
11 oz.	Glycerine,
11 oz.	Oil Turpentine,
11 lbs. 6 oz.	Blood Albumen Solution (1 lb. 11 oz. to the quart).

Steam Green on Cotton.

2 lbs. 3 oz.	Persian Berry Decoction, 4° B.,
4½ oz.	Starch,
2 oz.	Alum,
⅙ oz.	Oxalic Acid,
5½ oz.	Prussiate Tin,
3 oz.	Yellow Prussiate,
1 oz.	Acetic Acid, 8° B.

Steam Green on Cotton.

$13\frac{3}{4}$ lbs.	Persian Berry Decoction, 4° B.,
$3\frac{1}{2}$ lbs.	Gum Arabic,
$2\frac{1}{2}$ lbs.	Yellow Prussiate,
1 lb. 6 oz.	Sulphate Alumina,
9 oz.	Oxalic Acid,
2 oz.	Salts of Tin.

Steam Green on Cotton (Hawranek Green).

$1\frac{1}{2}$ lbs.	Starch, cooked with
5 quarts	Water. To the hot paste add
2 lbs. 6 oz.	Yellow Prussiate,
$9\frac{1}{2}$ oz.	Red Prussiate,
5 lbs. 6 oz.	Prussiate Tin,
$1\frac{1}{4}$ lbs.	Chrome Alum, dissolved in
1 pint	Water,
4 oz.	Acetic Acid, 8° B.

This Green is frequently printed with Guignet Green, with which it forms a pretty contrast, being much darker.

[It is much improved and darkened by passing through Bichromate, after printing and steaming. S. B.]

Sea-Green (Chrome Green).

In 9 quarts Water, dissolve

13 oz. White Arsenic; add gradually

12 oz. Bichromate Potash.

Boil and filter, drain the precipitate well and dissolve it in

13 oz. Muriatic Acid at 22° B. Boil the solution in an enamelled vessel to 50° B., and then add

1 oz. Sal-Ammoniac.

Before using for printing, warm the mixture and thicken with

$3\frac{1}{2}$ oz. Dextrine.

Green on Cotton.

2½ lbs. Soap. Dissolve in
8 quarts Soapwort Decoction, two ounces Saponaria officinalis (Soapwort) to the quart water. When cool, dissolve in it
2½ lbs. Sulphate Copper (Blue Vitriol), and thicken with
¾ lb. Pulverized Gum Tragacanth.

Aniline Green on Cotton.

1 lb. Aniline Green in paste,
¾ lb. Tragacanth Mucilage,
13 oz. Blood Albumen Solution.

Steam Green on Wool.

8 lbs. Yellow Lake,
9 oz. Oxalic Acid,
15 oz. Sulphate Alumina,
9¼ lbs. Solution Indigo Paste. Cook, and thicken with
3 lbs. Gum Arabic.

Steam Green on Wool.

8 lbs. Cuba Lake,
½ lb. Oxalic Acid,
13 oz. Sulphate Alumina,
8 lbs. Indigo Paste Solution. Cook, and thicken with
2¾ lbs. Gum.

Indigo Paste Solution.

2 lbs. Indigo Paste dissolved in
9 quarts Boiling Water. Filter.

Steam Green on Wool.

8 lbs. 9 oz. Quercitron Liquor, 20° B.,
6½ oz. Logwood Liquor, 20° B.,

1 lb. 10 oz. Indigo Paste,
6 lbs. Gum,
2 quarts Water. Cook, and add to the mixture, when cold,
11 oz. Alum,
11 oz. Oxalic Acid,
1 oz. Muriate of Tin, at 55° B.

ORANGES.

Dark Chrome Orange on Cotton.

5 lbs. Nitrate of Lead,
5 lbs. Pyrolignite of Lead,
½ lb. Starch,
½ lb. British Gum,
9 pints Water. Raise in Chrome for all the Chrome Oranges.

Dark Chrome Orange on Cotton.

10 oz. Starch, cooked to a paste with
5 gills Water; add
7 oz. Acetic Acid,
½ oz. Nitric Acid. When the paste has become thin and flowing, add gradually
24 lbs. Chrome Orange Standard, 50° B., No. 12.

Dark Chrome Orange for Cotton.

6 lbs. Chrome Orange Standard, 50° B., No. 12, cooked with
1 lb. British Gum,
½ lb. Indigo Paste Solution (page 99),
½ lb. Olive Oil.

Dark Chrome Orange for Cotton.

17 lbs. Chrome Orange Standard, 50° B., No. 12, thickened with
3 lbs. Leicome.

Chrome Orange on Cotton (middling light).

15 lbs. Sugar of Lead. Dissolve in
2 quarts Water. Add
29 quarts Dextrine Water ($1\frac{1}{2}$ lbs. to the quart).

Chrome Orange (light).

8 lbs. Sugar of Lead.
2 quarts Water,
29 quarts Dextrine Water.

To produce with regularity any shade of Chrome Orange, it is absolutely necessary that the goods should, before printing, be passed through a solution of Glauber Salts. Four and a half ounces of Sulphate of Soda to the quart of water, give a sufficient strength. The goods are passed in the vat with rollers.

Orange on Cotton.

3 lbs. Starch,
4 lbs. Pyroligneous Acid, 2° B.,
2 lbs. Persian Berry Decoction, 10° B.,
1 lb. 6 oz. Acetate Lime. Cook, and, when cold, add
2 lbs. 7 oz. Salts of Tin. Dissolve.

With this Orange, Black, Red or Chocolate Mordants may be printed, and the whole raised in Garancine.

Garancine Orange with Flavine.

2 lbs. Starch:
2 lbs. 3 oz. Flavine,
7 ounces White Arsenic,

9 quarts of Water. When cold, and just before using, add

2 lbs. 5 oz. Salts of Tin,

18½ ounces Acetate of Soda.

This color also gives, after steaming, a better Steam Orange than can be produced with Persian Berries.

Steam Orange.

4½ lbs. Persian Berry Liquor, 4° B.,

6 ounces Wheat Starch,

4½ ounces Acetic Acid, 8° B.,

1 ounce Sugar of Lead,

5½ ounces Sapan Wood Liquor, 10° B.

Cook together well, and when cold, add

2¾ ounces Salts of Tin.

Steam Orange on Cotton.

13½ lbs. Persian Berry Liquor, 8° B.

3½ lbs. Oxidized Sapan Liquor for Orange, No. 50.

4½ lbs. Acetate Alumina, 15° B.,

½ lb. Sulphate Alumina, 15° B.,

7½ lbs. Gum Arabic.

This color may be printed with Steam Blue.

Steam Orange on prepared Cotton.

8 lbs. Persian Berry Liquor, 7° B.,

4½ lbs. Cochineal Solution, 7° B.,

3½ pints Water, are cooked with

2 lbs. Starch. When the mixture is lukewarm, add

½ lb. Oxalic Acid, and

¾ lb. Salts of Tin, and, when fully cold, add

4 ounces Tin Composition for Orange 8, No. 27.

Steam Chrome Orange.

3½ lbs. Chrome Orange Pigment,

8 lbs. Egg or Blood Albumen Solution.

Steam Chrome Orange (light).

13 ounces Chrome Orange Pigment,
3 lbs. Chrome Yellow Pigment,
12 lbs. Egg or Blood Albumen Solution and
8 quarts Gum Water or Tragacanth Mucilage.

YELLOWS.

Steam Yellow on prepared Goods.

12½ lbs. Standard for Yellow,
1 lb. Sugar of Lead,
1 lb. Salts of Tin.

Steam Yellow I. on prepared Goods.

17½ lbs. Standard for Yellow,
1½ lbs. Salts of Tin,
1 lb. Sugar of Lead.

Standard for Yellow.

15 lbs. Persian Berry Decoction, 7° B.,
6 lbs. Gum Arabic.

Steam Orange I. on prepared Goods.

3 lbs. Steam Yellow I. (above).
1 lb. Steam Red, I.

Steam Yellow on prepared Goods.

7 lbs. Quercitron Liquor, 20° B.,
2½ lbs. Nitrate Alumina, 17° B.,
2½ lbs. Acetate Alumina, 15° B.,
½ lb. Sal-Ammoniac, and
6 ounces Oxalic Acid, are dissolved in
1½ pints of Water, and thickened with
6 lbs. Gum Arabic.

Steam Orange O. on Cotton.

1 lb. 3 oz. Anatto,
2 lbs 3 oz. Caustic Soda Solution, 10° B.,
6 ounces Sulphate Alumina,
$1\frac{1}{2}$ ounces Tartaric Acid, and
$6\frac{1}{2}$ lbs. Gum Water.
British Gum Water or Tragacanth Mucilage, may be used in place of the Gum Water.

Steam Yellow on Wool.

3 ounces Scarlet Red I. for Wool,
6 ounces Salts of Sorrel,
16 lbs. 6 oz. Persian Berry Liquor, 7° B.,
4 lbs. Gum Arabic and
13 ounces Muriate of Tin, 55° B.

Steam Yellow on Wool.

14 lbs. Persian Berry Liquor, 7° B.,
4 lbs. Gum Arabic,
11 ounces Muriate Tin, 55° B., and
1 lb. 6 oz. Steam Scarlet Red I. for Wool.

BUFF, NANKEEN, AND STRAW COLORS.

Dark Buff.

$3\frac{3}{4}$ lbs. Iron Liquor, 14° B.,
5 quarts Water,
1 lb. Flour,
1 lb. Starch,
$2\frac{3}{4}$ lbs. Copperas,
$2\frac{3}{4}$ lbs. Brown Sugar of Lead.

Nankeen I.

11½ lbs. Nankeen Standard I., 15° B.,
5½ lbs. Pyrolignite Alumina, 8° B., are cooked with
4 lbs. British Gum,
1 lb. Spirits Turpentine.

Nankeen 1–10.

1 lb. Nankeen I.,
10 lbs. Thin British Gum Water.

Nankeen 1–20.

1 lb. Nankeen I.,
20 lbs. Thin British Gum Water.

Dark Buff.

4¾ lbs. Nankeen Standard I.,
10½ oz. Copperas,
2 lbs. Gum Arabic.

Nankeen III.

14 lbs. Nankeen Standard III., 25° B.,
7 lbs. British Gum,
7 oz. Spirits of Turpentine.

Nankeen 3–6.

1 lb. Nankeen III.,
6 lbs. British Gum Water.

Nankeen 3–15.

1 lb. Nankeen III.,
15 lbs. British Gum Water.

Nankeen II.

4 lbs. Nankeen Standard II.,
6 lbs. Tragacanth Mucilage (½ oz. to the quart).

Steam Nankeen D., on prepared Goods.

4 lbs. Steam Orange I.,
1 lb. Steam Rose I.,
10 lbs. Gum Water.

Steam Nankeen O., on Cotton.

1 lb. Steam Orange O.,
10 lbs. Gum Water.

CATECHUS.

Standard A. for Catechu Colors raised in Madder or Garancine.

2 quarts	Water,
3 lbs. 10 oz.	Pyroligneous Acid, 2° B.,
2 lb. 7 oz.	Catechu,
$\frac{3}{4}$ lb.	Acetate Lime, 15° B.,
1 lb. 9 oz.	Sal-Ammoniac,
3 lbs.	Gum Arabic.

It is an advantage to wash the Catechu with cold water before using it. This dissolves out the tannin which is sometimes injurious, but does not dissolve the catechine.

Catechu I.

$6\frac{1}{4}$ lbs. Standard A.,
1 lb. Acetate Alumina, 12° B., and
$2\frac{3}{4}$ oz. Nitrate Copper, 55° B.

Catechu II., redder than I.

$6\frac{1}{4}$ lbs.	Catechu Standard A.,
1 lb. 10 oz.	Acetate Alumina, 12° B., and
$2\frac{3}{4}$ oz.	Nitrate Copper, 55° B.

Dark Catechu, to be raised in Garancine.

8 lbs.	Acetic Acid, 8° B.,
8 quarts	Water,
12½ lbs.	Catechu,
8 quarts	Gum Water or Tragacanth Mucilage,
14 oz.	Olive Oil,
6½ lbs.	Sal-Ammoniac,
6 lbs.	Acetate Copper, 19° B.,
½ lb.	Nitrate Copper, 55° B.

Catechu Reserve for Purple or Chocolate Over-Printing.

4 lbs.	Lemon Juice, 27° B.,
15 oz.	Acetic Acid, 8° B.,
1 lb. 14 oz.	Catechu,
17 oz.	Sal-Ammoniac,
1 lb. 5 oz.	Gum. Cook, and when cold, add
½ lb.	Nitrate Copper.

In dunging this reserve, some Bichromate must be added to the dung-bath. To 1,000 quarts, liquid, 4 lbs. Bichromate are sufficient.

Catechu Reserve.

2½ pints	Water,
7 oz.	Acetic Acid, 8° B.,
17 oz.	Catechu,
17 oz.	Sal-Ammoniac,
½ oz.	Crystallized Verdigris,
2¾ oz.	Crystallized Nitrate Copper,
2 oz.	Crystallized Citric Acid,
1 lb.	Gum Arabic.

Dark Catechu Standard.

2½ pints	Water,
2 lbs. 6 oz.	Pyroligneous Acid, 2° B.,
1 lb. 9 oz.	Catechu,

6	ounces	Acetate Lime, 15° B.,
1	lb.	Sal-Ammoniac.

Dark Catechu.

2	quarts	Dark Catechu Standard,
6	ounces	Starch,
$1\frac{1}{2}$	ounces	Acetate Alumina, 15° B.,
$2\frac{3}{4}$	ounces	Nitrate Copper, 55° B.

Catechu Standard for Gray raised in Garancine.

14	ounces	Catechu,
$\frac{1}{2}$	lb.	Sal-Ammoniac,
2	lbs. 3 oz.	Pyroligneous Acid, 2° B.,
1	quart	Water,
$1\frac{1}{4}$	lbs.	British Gum. Cook, and when cold add
$10\frac{1}{2}$	ounces	Pyrolignite Copper, 19° B.,
1	ounce	Nitrate Copper, 50° B.

Dark Catechu, 45.

1	quart	Catechu Standard for Gray,
$1\frac{1}{2}$	ounces	Iron Liquor, 15° B.

Dark Catechu, 90.

1	quart	Catechu Standard for Gray,
3	ounces	Iron Liquor, 15° B.

Dark Catechu, 150.

1	quart	Catechu Standard for Gray,
5	ounces	Iron Liquor, 15° B.,

These Grays may be rendered lighter by diluting with British Gum Water.

Catechu Gray, a.

1	quart	Standard A. for Catechu (page 106),
$1\frac{1}{2}$	ounces	Pyrolignite Alumina, 10° B.,
$\frac{1}{2}$	lb.	Iron Liquor, 10° B.,
$1\frac{1}{3}$	ounces	Nitrate Copper, 50° B.

Catechu Gray, b.

1 quart Standard A. for Catechu,
2 ounces Pyrolignite Alumina,
$\frac{1}{2}$ lb. Pyrolignite Iron, 10° B.,
1$\frac{1}{3}$ ounces Nitrate Copper, 50° B.

Catechu Gray, c.

1 quart Standard A. for Catechu,
1$\frac{1}{2}$ lbs. Gum Water,
1 ounce Pyrolignite Alumina, 10° B.,
1$\frac{1}{3}$ ounces Nitrate Copper, 50° B.,
8 ounces Pyrolignite Iron, 10° B.

Catechu Standard O.

5$\frac{1}{2}$ pints Water,
4$\frac{3}{4}$ lbs. Pyroligneous Acid, 2° B.,
3 lbs. Catechu,
2 lbs. 3 oz. Sal-Ammoniac,
14 ounces Acetate Lime, 15° B. Let stand 12 hours, and thicken the decanted liquor with
5 lbs. 2 oz. Dextrine.

Catechu O., to be raised in Garancine.

18$\frac{1}{2}$ lbs. Catechu Standard O.,
1 lb. Acetate Alumina, 11° B.,
9 oz. Nitrate Copper, 50° B.

Catechu to be raised in Madder or Flowers.

2$\frac{1}{2}$ lbs. Catechu,
8 lbs. Pyroligneous Acid, 2° B.,
$\frac{3}{4}$ lb. Gum Arabic,
$\frac{3}{4}$ lb. Verdigris in Crystals,
2 lbs. Sal-Ammoniac,
6$\frac{1}{2}$ lbs. Gum Water.

Catechu Standard M. for Garancine Gray.

10 quarts Water,
8 lbs. Catechu,
5 lbs. Sal-Ammoniac,
4 lbs. Pyroligneous Acid, 2° B.,
3 lbs. Pyrolignite Copper, 15° B.,
14 lbs. Gum Arabic.

Garancine Gray.

10 quarts Catechu Standard M.,
2 quarts Gum Water,
5 oz. Muriate Iron, 40° B.

This same recipe will answer for other Catechu Grays by increasing the amount of Muriate of Iron, at 40°. As high as 20 ounces of Iron may be used.

STEAM CATECHUS.

Dark Steam Catechu on Cotton.

3½ lbs. Sapan Liquor, 2° B.,
½ lb. Acetic Acid, 8° B.,
½ lb. Catechu,
2 oz. Sal-Ammoniac,
1½ oz. Verdigris in crystals,
2 lbs. Gum Arabic.

Light Steam Catechu on Cotton.

In 15 pints Water, dissolve
3 lbs. Catechu and let settle.
To 5 quarts of the clear liquor, add
4 oz. Sal-Ammoniac,
4 oz. Nitrate Copper, 55° B.,
6 lbs. Gum Arabic.

Steam Catechu Standard P.

5 quarts	Water,
18 oz.	Acetic Acid, 8° B.,
3 lbs.	Catechu,
7 lbs.	Gum Arabic.

Steam Catechu P., on Cotton.

18½ lbs.	Steam Catechu Standard P.,
6 oz.	Chlorate Potash,
2½ lbs.	Nitrate Alumina, 17° B.,
7 oz.	Nitrate Copper, 55° B.

Steam Catechu on Wool.

2 lbs. 10 oz.	Catechu,
¾ lb.	Quercitron Liquor, 20° B.,
6 oz.	Sapan Liquor, 20° B.,
3 quarts	Water,
3½ oz.	Sal-Ammoniac,
3¾ oz.	Chlorate Potash,
13 oz.	Sulphate Alumina,
3 quarts	Gum Water.

Dark Steam Catechu on prepared Cotton.

2 lbs. 6 oz.	Starch,
3½ oz.	British Gum,
4 lbs. 10 oz.	Quercitron Liquor, 20° B.,
1 lb.	Sapan Liquor, 20° B.,
5 oz.	Logwood Liquor, 20° B.,
11 pints	Water,
1 lb.	Alum,
1½ oz.	Chlorate Potash.

Cook, and after it is cold add

2½ oz.	Red Prussiate Potash.

GRAYS.

Mineral Gray on Cotton.

1 lb. Lampblack,
3 lbs. Oil Vitriol, 66°.

Stir well together, and let stand 12 hours. Then wash well with water, and filter. To the paste on the filter, add 2 quarts of water, and rub it well together. Then add 11¼ lbs. of a solution of Blood Albumen (1 lb. 10 oz. of the Albumen to the quart of water).

Bluish Mineral Gray.

4 lbs. of the above Mineral Gray,
6 lbs. Ultramarine O.

Ultramarine O.

1 lb. Ultramarine, 3 F.,
3 lbs. Blood Albumen Solution.

Steam Gray C. C. on Cotton.

4 lbs.	Logwood Liquor, 20° B.,
1 lb.	Quercitron Liquor, 20° B.,
1 quart	Water,
¾ lb.	Sal-Ammoniac,
5 lbs.	British Gum,
3½ lbs.	Iron Liquor, 10° B.,
1 lb.	Blue Vitriol,
18 oz.	Iron Composition for Steam Gray C. C. Prep. No. 20.
1 lb. 14 oz.	Sulphate Chrome, 55° B.,
15 oz.	Spirits Turpentine,

To render this color lighter, it may be diluted by adding to it more or less of the following composition:

17 pints	British Gum Water (1½ lbs. to the quart),
1½ lbs.	Iron Composition for Gray C. C.,

$1\frac{1}{4}$ lbs. Sulphate Chrome, 35° B.,
$\frac{1}{2}$ lb. Spirits Turpentine,
$\frac{1}{2}$ lb. Nitrate Ammonia.

Steam Gray A. G. on Cotton.

9 quarts Gray Standard, A. G. (Mor. No. 15),
$1\frac{3}{4}$ lbs. Starch,
$1\frac{1}{4}$ lbs. British Gum.

This color may be diluted with the ordinary British Gum Water. It need not necessarily be steamed to fix it. Hanging in a warm damp room and then passing through a chalk-bath is sufficient.

Steam Gray on Cotton.

8 lbs. Tragacanth Mucilage,
9 pints Water,
3 lbs. Gray Standard, A. G. No. 15.

Steam Gray on Cotton.

1 lb. 14 oz. Logwood Liquor, 10° B.,
7 oz. Sapan Liquor, 20° B.,
$3\frac{1}{2}$ oz. Cuba Yellow Wood Liquor, 20° B.,
$5\frac{1}{2}$ lbs. British Gum,
11 pints Water,
2 lbs. 3 oz. Acetate Chrome, 15° B.

Steam Gray C. on Cotton.

To $3\frac{3}{4}$ lbs. Logwood Liquor, at 10° B., add gradually a solution of
$5\frac{1}{4}$ oz. Bichromate of Potash in
9 pints Water, and
15 oz. Muriatic Acid.

Cook the mixture, and, while hot, thicken with
$5\frac{3}{4}$ lbs. British Gum; then add
$8\frac{1}{2}$ oz. Acetate Protoxide of Iron, 10° B.,
13 oz. Sulphate of Chrome, at 50° B.

This Gray may be lightened with the following Gum Water:—

Gum Water for Gray C.

10 lbs. Dextrine Gum Water (2 lbs. to the quart),
10 pints Water,
5¼ oz. Sulphate Chrome, 50° B.

Steam Gray on Cotton.

2½ lbs. Oxidized Logwood Liquor, 10° B.,
2 lbs. Tragacanth Mucilage (2 oz. to the quart),
½ lb. Starch,
2 oz. Leicome,
⅓ oz. Bichromate Potash,
1 oz. Muriatic Acid,
½ lb. Acetate of Chrome, 15° B.

Oxidized Logwood Liquor.

8½ lbs. Logwood Liquor, 10° B.,
2 oz. Bichromate Potash,
1¾ oz. Muriatic Acid.

Steam Gray on Cotton.

1½ lbs. Logwood Liquor, 20° B.,
1 lb. 14 oz. Pyrolignite Alumina, 10° B.,
5 pints Water,
1¾ lbs. British Gum,
½ lb. Acetate Chrome, 15° B.

Steam Gray on Cotton.

5 quarts Gum Water,
2¼ lbs. Decoction Nutgalls, 10° B.,
5½ oz. Muriate Iron, 40° B.

Steam Gray on Cotton.

4 lbs. Logwood Liquor, 8° B.,
2 lbs. Iron Liquor, 7° B.,
8 lbs. Leicome Water.

OLIVES.

Olive on Cotton.

13 pints Water,
3 lbs. Quercitron Liquor, 20° B.,
14 oz. Starch,
2 lbs. 3 oz. Leicome,
2 lbs. Copperas.

Dark Steam Olive on Cotton.

2 lbs. 13 oz. Persian Berry Liquor, 7° B.,
7½ pints Water,
1 lb. 7 oz. Acetic Acid, 8° B.,
1¼ oz. Logwood Liquor, 20° B.,
2 lbs. Alum,
2 lbs. Sugar of Lead,
2¾ lbs. Starch,
are well cooked together. After it is cold, add
2 lbs. 6 oz. Muriate Iron, 40° B.

Steam Olive on Cotton.

4 lbs. Quercitron Liquor, 4° B.,
1 lb. Iron Liquor, 5° B.,
6 lbs. Gum Water.

MODE COLORS.

Mode Standard.

13 lbs. Solution Catechu in Water, 8° B.,
1½ lbs. Pyroligneous Acid, 2° B.,
7¼ lbs. British Gum.

Mode 2–1.

2 lbs. Mode Standard,
1 lb. Iron Preparation for Modes, No. 36.

Mode 5–3.

5 lbs. Mode Standard,
3 lbs. Iron Preparation, No. 36.

Mode 1–3.

1 lb. Mode Standard,
3 lbs. Iron Preparation, No. 36.

Mode 1–8.

1 lb. Mode Standard,
8 lbs. Iron Preparation, No. 36.

Mode 1–13.

1 lb. Mode Standard,
13 lbs. Iron Preparation, No. 36.

These mode colors may be fixed by steaming, or by passing through a chalk or chrome bath after ageing 12 hours.

Steam Mode Gray on Cotton.

6 lbs. Iron Liquor, 10° B.,
½ lb. Acetic Acid, 8° B.,
½ oz. Logwood Liquor, 20° B.,
1 gill Water,
3 oz. Alum,
9 oz. Sal-Ammoniac,
12 lbs. Gum Arabic.

Steam Mode Gray on Cotton.

11 lbs. Pyroligneous Acid, 2° B.,
2 lbs. Iron Liquor, 14° B.,
2 lbs. Decoction of Galls, 4° B.,

$\frac{3}{4}$ lb.	Sulphate Chrome, 50° B.,
1 oz.	Logwood Liquor, 20° B.,
1 quart	Water,
1 lb. 14 oz.	Sal-Ammoniac.

RESERVES AND DISCHARGES.

For Reds, Pinks, and Purples Over-Printing.

3 lbs.	Tartaric Acid, dissolved in	2	quarts	Water,
$1\frac{1}{2}$ lbs.	Bichromate Potash, "	"		"
1 lb.	Calcined Soda, "	1		"
8 lbs.	British Gum. Cook.			

For Same.

12 lbs.	Lemon-Juice, 30° B.,
8 lbs.	British Gum,
1 lb.	Flour,
$1\frac{1}{2}$ oz.	Oil. Cook, and when cold, add
$3\frac{3}{4}$ lbs.	Bichromate Potash, and
3 lbs.	Tartaric Acid, dissolved in
3 quarts	Water.

For Catechus, Chocolates, or above Colors.

12 lbs.	Citric Acid in Crystals,
3 gallons	Water,
8 lbs.	British Gum. Cook.

For Purples and Pinks.

$6\frac{1}{2}$ lbs.	Caustic Soda Solution, 15° B.,
$6\frac{1}{2}$ lbs.	Lemon-Juice, 30° B.,
2 lbs.	British Gum.

Discharge for Goods padded in Acetate of Alumina or Acetate of Iron.

$7\frac{1}{4}$ lbs. British Gum,
15 lbs. Lime-Juice, 30° B.,
2 quarts Water,
2 lbs. Bisulphate of Soda,
3 lbs. Calcined Soda,
6 lbs. Oil Vitriol.

Reserve for Machine Printing.

12 lbs. Arseniate of Potash (or Soda),
25 lbs. Water,
10 lbs. British Gum.

Another.

4 lbs. British Gum,
$5\frac{1}{2}$ lbs. Arseniate Potash (or Soda),
3 lbs. Soda Crystals,
1 gallon Water.

Resist for Catechus and Chocolates.

68 lbs. Lime-Juice, 30° B.,
30 lbs. Soda Lye, 30° B.,
2 lbs. Citric Acid in Crystals,
$\frac{4}{5}$ lb. Sulphate of Indigo,
5 lbs. Wheat Starch.

Yellow Reserve for Indigo-Vat.

$3\frac{1}{4}$ pints Water,
$3\frac{1}{4}$ lbs. Sulphate Copper,
5 lbs. Nitrate of Lead,
$2\frac{2}{5}$ lbs. Sulphate of Lead,
$3\frac{1}{4}$ lbs. British Gum.

Resist for Chrome Orange or Aniline Black.

1½ gallons	Water,
7½ lbs.	Arseniate Potash (or Soda),
1 lb.	Hog's Fat,
10 lbs.	British Gum,
4 lbs.	Acetic Acid, 7° B.

Resist for Steam Colors.

¾ lb.	Glue,
7 pints	Water,
4¾ lbs.	Pipe-Clay,
4¾ lbs.	Gum Water.

Reserve for Ultramarine.

6 lbs.	China Clay,
1 quart	Water,
3 lbs.	Gum Water,
1½ lbs.	Citric Acid in Crystals,
1 quart	Water.

Reserve for Indigo-Vat.

1 lb.	Verdigris, soaked in
1½ pints	Water. After 24 hours, add
¾ lb.	Cream of Tartar, and thicken with
¾ lb.	British Gum. Then add
1 quart	Gum Water, and
1½ lbs.	Nitrate Copper, 50° B.

Reserve for Indigo.

15 lbs.	Verdigris,
24 lbs.	Pyroligneous Acid. Soak, and add
6 lbs.	Cream of Tartar,
6 lbs.	Brown Sugar of Lead,
8 lbs.	Blue Vitriol,
12 lbs.	British Gum.

Discharge for Chrome Orange.

In $4\frac{1}{2}$ lbs. Tragacanth Solution ($1\frac{1}{2}$ oz. to quart Water) dissolve with heat,
$1\frac{1}{2}$ lbs. Tartaric Acid,
$\frac{3}{4}$ lb. Oxalic Acid; then add
$\frac{1}{2}$ lb. Pipe-Clay,
1 lb. Tin Solution (2 lbs. of Tin Crystals in 1 lb. Muriatic Acid).

Discharge for Prussian Blue.

3 lbs. Caustic Soda Lye,
1 lb. British Gum.
1 hour after printing, Wash. The parts printed will appear of a yellow rust color, and to remove this, the pieces must be taken through acid.

MADDER EXTRACT.

Formerly, the madder root, simply dried and ground, was exclusively employed in printing. But it is evident that so complex a substance as a root, contains, besides the coloring substance or useful principle, other bodies capable of counteracting this principle and injuring the beauty of the tints derived from it.

For the purpose, therefore, of eliminating these useless substances, there is now produced on a manufacturing scale, and can be found in market,

1. *Flowers of Madder* (fleur de garance), or the ground root deprived of its soluble portions, by washing it with water. The madder loses by this washing about 50 per cent. of its weight. The flower, therefore, possesses a coloring power double that of madder, and works with more regularity in dyeing.

2. *Garancine*, or the ground madder treated with sulphuric acid, washed and dried. In the preparation of garancine, the foreign substances are more completely eliminated than by water alone, so that a more concentrated article is produced; and not only this, but a part of the coloring substance is liberated from its combination with the pectates of lime and glucosides contained in the madder root, which, unless so liberated, would be lost in working. The proportion of coloring matter so liberated amounts to not less than half of the total quantity contained in the root, and repays well the expense of making it into garancine.

3. *Commercial Alizarine;* or superheated garancine. This preparation has met with great success, on account of the beauty of the purples it furnishes with the mordants of iron. The heat (392° F.) destroys a yellow or tawny principle which injures the brilliancy of the colors, particularly the purples.

In these three products, a portion of the woody fibre of the root still remains, so that they can be used only in the old form of raising, in the usual madder-beck, the goods on which the mordants have been previously printed.

If the color could be separated from the woody fibre so that it could be printed directly on the cloth, the immense advantage of this process would cause it to be adopted eventually by all calico-printers. But it is to be remembered that so great a change in a manufacture which has existed for centuries, cannot take place suddenly. In the present state of things, however, it is easy to foresee that the old process will gradually but certainly be replaced by the new, which is by the employment of

4. *Extract of Madder.* An extract from madder sufficiently pure to be employed in printing directly upon the cloth has been long sought for, but it is only within a few years past that this result has been attained, at a price which would permit it to be employed. The processes now in use for manufacturing it, may be reduced to three in number.

The first consists in boiling garancine with a weak solution of alum. By this means, nearly all the coloring matter may be extracted in a condition of great purity, and the color precipitates from the alum solution on cooling, with the addition of a little sulphuric acid. It is then collected on a filter, carefully washed, and, in the condition of a paste, is ready for use in printing. The defect of this process consists in the loss of the alum and the acid, which are washed away; and also in the fact, that the paste obstinately retains a little alumina, even after the most careful washing, and therefore the *purples* made by it are not quite satisfactory.

The *second* was published by Emil Kopp, in 1867, and is very ingenious. It consists in extracting the color from the fresh madder by means of water acidulated with sulphurous acid, and in purifying the color so extracted by boiling it with one of the cheap hydro-carbon oils — coal-oil or petroleum — in which it dissolves. The petroleum solution is then treated with a weak solution of caustic soda, which deprives the petroleum of the color, and leaves it (the oil) in a state to be used over again. The soda solution is then treated with a weak sulphuric or muriatic acid, which precipitates the color in the form of a paste, which, after washing, is ready for use. The madder residue is then converted into garancine, and from this, an additional quantity of color is extracted by similar means.

The *third* process is due to Schutzenberger, and consists in the extraction of the color from garancine by means of water heated to a very high temperature, say at a pressure of 125 to 150 pounds of steam. The color falls from the water on drawing off and cooling. The extract so made is excellent.

The objection to this process is the difficulty of operating at so great a pressure, and from the necessity of the vessel's being of small capacity, to resist the pressure. A modification of it is therefore also in use, which consists in passing

superheated steam through moist garancine, and condensing the watery extract so made.

The above are the only processes that appear to have succeeded on a practical scale for obtaining an extract of madder sufficiently pure and sufficiently cheap to be employed in printing. The extraction of the color by means of alkalies, potash, soda, or ammonia, which is by far the easiest and cheapest mode, — as any one may convince himself of by shaking up a little garancine in a test-tube with ammonia water, — has failed, in consequence of the alkali dissolving the resin, fat, and pectic acid, as well as the color. This renders it wholly unfit for printing, but does not prevent its employment in the dye-beck. There would in this case, however, be no advantage in using the alkaline extract instead of the madder from which it was made. But this subject needs further investigation, and would probably well repay the researches of any competent chemist. The fact stated by Persoz, of the great advantage to be derived from the addition of soap to the dye-beck is, perhaps, owing to the alkali of the soap rendering the solution of the color, by the hot water, more complete, without being present in sufficient quantity to dissolve the injurious components of the madder.

The principal conditions necessary to success in printing either of the above extracts are, —

1. That the extract be pure and concentrated.

2. The substitution of *pure* acetate of alumina for the old red liquor mordant, which contains acetate of potash or ammonia, in addition to the acetate of alumina.

3. The employment of a *solvent* for the color, which is acetic acid.

4. The addition of certain substances to give a certain degree of hygrometric property to the color, such as salts of lime, oils, or fatty acids.

The color thus prepared, and properly thickened, is to be

printed in accordance with the following recipes. The "doctor" must be of composition, and not of steel.

Reds on unprepared Cotton.

2 quarts Madder Extract,
3 pints Acetic Acid, at 8° B.,
1 lb. Olive Oil, are cooked together. Then as much acetic acid as has been steamed off must be restored by fresh acid, and the mixture thickened with
3 lbs. of powdered Gum Arabic.
Immediately before using,
1 pint of Acetate of Alumina, at 15° B., is added, as the mordant.

It is essential not to add the mordant until just before using, for the color does not maintain its combination with the mordant very long.

The acetate of alumina is made either by dissolving 2 quarts of alumina in paste, in 1 quart of acetic acid, at 8° B., or by the following recipe: —

In 3 quarts of Water, dissolve
4 lbs. Sulphate Alumina, and then
6 lbs. Sugar of Lead. Let settle, and use the clear liquor.

Pinks on unprepared Cotton

are produced by the same process as the reds, diluting the color with Gum Water, acidified with a little Acetic Acid.

Purples on unprepared Cotton.

1 quart Madder Extract,
1 quart Acetic Acid, 8° B.,
½ lb. Olive Oil, are cooked together for some time. The Acetic Acid which has evaporated must be restored by fresh acid, and the whole thickened

with $1\frac{1}{4}$ lbs. Gum Arabic in powder. Immediately before using, add

$\frac{1}{2}$ lb. Iron Liquor, 11° B.,

$\frac{1}{4}$ lb. Arseniate Soda, at 6° B.

Lighter shades of purple are produced by diluting the color with sour Gum Water.

Chocolate on unprepared Cotton.

2 quarts Madder Extract,

2 quarts Acetic Acid,

Cook. Replace what Acetic Acid has evaporated, and thicken with Gum Arabic, and when cold, add

3 quarts of Acetate Chrome, 17° B.

Chocolate on unprepared Cotton.

1 lb. Madder Extract,

1 lb. Acetic Acid,

2 ounces Olive Oil,

$2\frac{1}{2}$ ounces Wheat Starch.

Cook. Replace the evaporated Acetic Acid, and when cold, add

$3\frac{1}{2}$ ounces Acetate Chrome, made as follows:—

Acetate of Chrome.

4 ounces Chrome Alum,

4 ounces Sugar of Lead,

$\frac{1}{2}$ pint Water.

Catechus may be printed at the same time with Madder Extract, by any of the processes for Steam Catechus; also the following pigment colors:—

Blues.—Ultramarine, with Albumen solution.

Greens.—Guignet Green, with Albumen solution.

Orange.—Orange pigment, No. 29, with Albumen solution.

Blacks.—Logwood Black, by this recipe.

$5\frac{1}{4}$	lbs.	British Gum,
3	quarts	Water,
4	lbs.	Logwood Liquor, 20° B.,
18	ounces	Acetic Acid, 6° B.,
$7\frac{3}{4}$	lbs.	Acetate Chrome, 17° B.,
10	ounces	Chlorate Potash, dissolved in
3	gills of	Water.

Or this.

$1\frac{3}{4}$	lbs.	Logwood Extract (solid),
1	pint	Acetic Acid, 8° B.,
1	pint	Olive Oil,
$\frac{1}{2}$	lb.	British Gum,

Cook well; restore the acid that steams off. Just before printing, stir in well 1 pint of a mixture of

$\frac{2}{3}$	pint	Acetate Chrome, 16° B.,
$\frac{1}{3}$	pint	Acetate Iron, No. 8. (S. B.)

After printing, the goods are steamed $1\frac{1}{2}$ or 2 hours at a low pressure, say 15 lbs.; then washed, and soaped in a soap-bath at 125° to 165° F. Again washed and soaped a second time if necessary. If the whites are not satisfactory, the goods may be passed through a weak chemic.

As the employment of Madder Extract is of very recent introduction, but little is known as yet of the capabilities of this process, and an interesting field is opened for intelligent experimentation. It will be observed that in all the recipes, the color is held in solution by Acetic Acid, but it is equally soluble in Potash or Soda, and particularly so in Ammonia Water. In this case, of course, Acetate of Alumina could not be used as the mordant in the color, but the goods might be padded with it previous to printing. It is also soluble in Gallipoli oil, 3 lbs. Extract to 1 quart of Oil and 1 lb. of British Gum. With this, the Acetate of Alumina, could of

course be used as the mordant. Red Prussiate of Potash with the Extract produces a purple and Acetate of Uranium a gray. A little Pyrolignite of Iron, deepens the Chocolates.

Since the above was written, I have been favored with the communication of the experience of a very accomplished chemist, Mr. Spencer Borden, of Fall River, with regard to the use of Madder Extract. He gives the following recipes as those he has found the best:—

Dark Red on unprepared Cloth.

8 lbs. Extract of Madder,
4 pints Acetic Acid, 8°,
2 pints Water,
1 pint Acetate of Lime, 5° T.,
$1\frac{3}{4}$ lbs. Starch.
Cook, and when cold, replace the loss by evaporation with Acetic Acid at 4°. Then, just before printing, add $1\frac{1}{2}$ pints Acetate Alumina, 15°.

Medium Red on unprepared Cloth.

8 lbs. Extract of Madder,
4 pints Acetic Acid, 8°,
5 pints Gum Water (6 lbs. to the gallon).
Manipulate as the preceding, and add the same amount of mordant.

Pale Red on unprepared Cloth.

The same as for Medium Red reduced to the shade required with Gum Water.

In all cases the Alumina is to be added when the color is quite cold, and just before printing. The color itself will keep good for weeks.

Purples on unprepared Cloth.

8 lbs. Madder Extract,
4 pints Acetic Acid, 8°,
6 quarts Gum Water,
1 pint Acetate Protoxide Iron, 20° T.

Lighter shades may be produced by diluting with Gum Water. Darker shades may be thickened with Starch instead of Gum.

The goods, after printing, are to be cooled. Steam for two hours, with moist steam the first hour and a half; the last half hour at a higher pressure. The *time* of steaming however is of more importance than the pressure.

After steaming, wash well, soap first at 120° F., and a second time at 170° F. Gently clear and finish.

The Madder Extract may also be used in an alkaline solution, if the cloth is first prepared with the mordant. This is done as follows: Pad the goods in a mixture of

3 parts of Red Liquor, 5° T.,
1 part of Acetate Lime, 5° T.,

Dry well and pass through the ageing room; then print with the following color:—

Reds and Pinks on prepared Cotton.

1½ lbs. Madder Extract,
¾ lb. Saccharate of Soda Solution,
1 gallon Water,
1 lb. White Starch. Cook.

Or this.

1½ lbs. Madder Extract,
6½ lbs. Soap Solution.
1 lb. Starch. Cook.

Saccharate of Soda Solution.

Boil together 1 pint Caustic Soda, 58° T.,
1 quart Water,
$1\frac{1}{4}$ lbs. Brown Sugar,
until all the sugar be dissolved.

Soap Solution.

Dissolve 1 lb. ordinary Soap,
in 1 gallon Water.

ARTIFICIAL ALIZARINE.

It is scarcely more than four years ago that the chemical world was surprised by the announcement that two chemists of Berlin, Messrs. Græbe and Liebermann, had succeeded in forming *alizarine* out of some of the products of coal-tar. The announcement was received at first with incredulity, but it soon became recognized as an established fact, that this substance, hitherto found only in madder and some of its cognate plants, could really be produced in the laboratory of the chemist. It was not supposed at first that this discovery would have any practical value, but that the artificial alizarine would remain for a long time a mere chemical curiosity. Such, however, has not proved to be the fact. It is now manufactured on a commercial scale by some half-dozen houses, and is offered in the market at such prices as to compete, *it is claimed*, successfully, with the natural extracts of madder.

Dr. Grothe, in the "Muster Zeitung," recommends the following recipes for printing with it. It will be observed that they differ from the recipes for *madder extract*, chiefly in the fact that the alizarine paste is not cooked with the thickening, but is added afterwards, and at the same time with the aluminous mordant; and also, that no directions are given for

restoring the acetic acid that evaporates in the cooking. It is not probable that this will prove to be any improvement; but each printer must determine, by his own experience, which mode of mixing is the best.

Reds.

5 lbs.	Alizarine paste,
16 lbs.	Thickening,
1 lb.	Acetate of Alumina, 10° B.,
½ lb.	Acetate of Lime, 16° B.

Pinks.

The same, diluted with 2 or 3 parts Thickening.

For double printing, when deep red is printed on first, the goods must be steamed one hour, before the second printing takes place. After the second printing, the goods must be again steamed one hour, and hung up to air. After hanging 24 hours, they are to be passed through either of the following baths:

250 gallons	Water,
60 lbs.	Chalk,
3 lbs.	Salts of Tin.

Or this.

250 gallons	Water,
40 lbs.	Chalk,
10 lbs.	Arseniate Soda.

The bath must be at a temperature of 120° to 140° F., and the goods stay in the bath 1 to 1½ minutes. They are then washed, and afterwards brightened as follows:

For 10 pieces, fifty yards each.

1st Soaping,	3 lbs. Soap, ¼ lb. Salts Tin, 122° F., ½ hour,
2d "	3 lbs. Soap, no Salts Tin, 167° F., ½ hour,
3d "	3 lbs. Soap, no Salts Tin, 170° to 177° F., ½ hour.

Wash between each soaping.

Thickening for Reds.

12 lbs.	Wheat Starch,
20 quarts	Water,
4 quarts	Acetic Acid, 6° B.,
10 quarts	Tragacanth Mucilage (2 ounces to quart),
3 lbs.	Olive Oil. Cook.

Acetate of Alumina.

30 lbs.	Hydrate of Alumina, are stirred into
6 quarts	Acetic Acid, warmed and filtered, and reduced to the required degree.

It will generally be found necessary to employ an amount of Acetate of Alumina, at 12° B., equal to 20 per cent. of the weight of the Alizarine paste.

Hydrate of Alumina.

72 lbs. Alum, in 100 gallons Water,
are precipitated with
62 lbs. Soda, in 100 gallons Water.

The precipitate is washed 8 times by decantation, collected on a filter, and squeezed out.

Acetate of Lime Solution.

A solution of Acetate of Lime, at 16° B., contains 25 per cent. of Acetate of Lime. Generally an amount of the solution equal to 10 per cent. of the Alizarine paste is required in the color. But it is well, with every new lot of Alizarine, to try, on a small scale, how much Acetate of Lime it requires, before using it for printing.

Red for Mosiacs (Mille-fleurs).

8 lbs.	Alizarine paste,
10 quarts	Thickening,
$9\frac{1}{2}$ oz.	Nitrate Alumina, 15° B.,
19 oz.	Acetate Alumina, 10° B.,
13 oz.	Acetate Lime, 16° B.

Very Deep Red.

10 lbs. Alizarine paste,
10 quarts Thickening,
13 oz. Nitrate Alumina, 15° B.,
19 oz. Acetate Alumina, 10° B.,
16 oz. Acetate Lime, 16° B.

Nitrate of Alumina.

2 lbs. Nitrate Lead,
2 lbs. Alum,
2 quarts Water.

With Nitrate of Alumina the Red is more yellow than with the Acetate; and when Nitrate is employed, an increased quantity of Acetate of Lime must be used.

Another Red without Oil.

8½ lbs. Alizarine paste,
9½ lbs. Acetic Acid, 8° B.,
3½ lbs. Flour,
5 pints Water.

Cook well; stir till cold, and then add
1 lb. Acetate Lime, 16° B.,
2 lbs. Nitrate Alumina, 15° B.,
3 lbs. Hyposulphite Lime, 9° B.

Purples.

3 lbs. Alizarine paste,
10 quarts Purple Thickening,
6 oz. Pyrolignite Iron, 12° B.,
12 oz. Acetate Lime, 16° B.

Purple Thickening.

10 lbs. Starch,
18 quarts Water,
9 quarts Tragacanth Mucilage (2 oz. to quart),

3 quarts Acetic Acid, 6° B.,
2 lbs. Olive Oil.
Cook well, and stir till cold.

The goods are steamed 1 to 2 hours at 8 lbs., and then hung to air 24 to 26 hours. They are then passed in a padding machine through the chalk and arseniate bath, the same as for Reds; washed and soaped, once only, without any tin in the soap-bath. If necessary, they may be lightly chemicked after soaping.

WOOL-SCOURING.

The first operation in dyeing is the scouring of the wool, and this is an operation that requires as much attention, if not more, than any subsequent one in the art of woolen-dyeing; yet it is the most neglected. If the wool is properly cleansed, we can produce better and more brilliant colors than we can if it is but half scoured. This, any intelligent and skilful dyer will admit; but we must say that a greater number of the dyers will assert, that there is not so much need of having the wool perfectly clean for dark colors as it is for the light shades, or for the blue-vat. This is a very erroneous idea, and there is no reason whatever for such a distinction. The wool cannot be got too clean for any of the colors; and we wish to impress it forcibly upon the attention of not only the dyer, but also the manufacturer, to see that the wool is perfectly clean for all shades and colors. How often do we hear complaints from the carder that his cards *gum up;* that he has to have them cleaned twice a day; that he has to clean his burr-picker four to six times in picking a thousand pounds, when all the cause of this trouble and work is the uncleanliness of the wool; and when the cloth which is manufactured from such wool is fulled and scoured, the dyer finds that his colors have *run*, which he lays to the finisher, and says that he uses too strong soap, &c., &c., when all the fault lies at his own door, on account

of his negligence in not having the wool scoured clean. Whenever dyers will be more particular in regard to cleaning their wool before coloring it, and use the proper coloring materials (those kinds that give the most permanent colors), we shall not hear so much about the finisher allowing the use of soaps too strongly alkaline for fulling, and so much about his destroying the colors, &c. If the wool is perfectly clean, the coloring-matter of such dyestuff as is used to produce the color, will have a chance to penetrate the fibre of the wool, thereby causing it to be more permanently fixed; but if the wool is unclean, the color is only fixed superfluously upon the outside of the fibre, and not within it. We will admit that a color can be made to look very well upon wool that is not perfectly clean; but let us follow this unclean wool through the process of manufacturing it into cloth. In the first place, it will cord and spin bad. It will require more oil than clean wool, to overcome the adhesivness of the greasy, paste-like substance left upon it before it was colored, which, by the boiling it gets in the operation of coloring, causes this pasty matter to adhere more firmly to the wool. There is also a greater loss by waste than there would be if the wool was clean. In spinning it will break oftener; it will not draw out, or make so fine, even, or strong yarn.

But the worst of all the bad effects unclean wool has is, that when the cloth made from it comes to the finishing-room to be fulled and scoured, it can hardly be scoured clean; and if it is got perfectly clean, it is done by using a scour-liquor of such an alkaline strength as not only to injure the texture of the cloth, but to nearly destroy the color; and what is left of the color, after the cloth has been cleansed, is lifeless and poor; but for all this the dyer will curse the finisher, because the colors do not *stand*, and look as they were expected to.

The above enumerated evils, in not having the wool clean to commence with, are enough, without naming others, to show how essential it is to have the wool *perfectly clean* before it leaves the dye-house, or the dyer attempts to color it. It

is for the interest of the dyer to attend particularly to the cleansing of the wool, so that he may have a perfectly clean ground on which to fasten his colors, for upon unclean wool it is impossible to produce a clear, bright and permanent color. If the wool is clean, his colors will be bright, and all the operations of manufacturing it into cloth will have a tendency to improve the beauty and lustre of the colors and fabric.

Every dyer, as a general thing, has his own particular method of scouring the wool, some using soda-ash and salt, others, sal-ammoniac and the different patent wool-cleansing detergents or compounds; but no matter how or by what process you scour the wool, only get it perfectly *clean*, and not use so strong an alkali as to cause the wool to feel harsh and sticky to the hand, but have it feel soft and buoyant, and when it is shaken up it will fall apart loose and feathery, having no smell of the sheep about it. Therefore we will not dictate to the dyer in this matter, but will merely give one or two recipes for making scouring liquor, which we have used, and know them to be better than all the patent cleansing compounds extant.

Uriate Scouring Liquor.

25 lbs.	Soda-ash,
2 lbs.	Borax,
15 lbs.	Coarse Salt,
2 gallons	Aqua Ammonia.

Put the three first substances into a barrel holding 42 gallons, fill half full of water, boil until all is dissolved, then fill the barrel up with cold water, and add the ammonia, and keep it covered up, in order that the ammonia may not evaporate. Use one quart of this for every 50 lbs. of wool.

In setting a new scour, use 4 gallons of the solution.

Another.

Dissolve 20 lbs. of guano in a 42-gallon barrel of boiling water, then add 15 lbs. soda-ash, stir until it is dissolved.

To start a fresh Scour.

For every 100 gallons of water that the scour-tub will hold, add 5 lbs. soda-ash, and 2 quarts of soap, and 1 quart of the guano liquor. Then for every 50 lbs. of wool after the first, use 1 quart of the guano liquor.

SCOURING THE CLOTH FOR PIECE-DYEING.

The pieces should be thoroughly scoured, after fulling, before they are sent to the dyer, otherwise, after they are colored, they will be cloudy. Yet we have known cases where the colors were more or less cloudy, when they were perfectly *clean;* in this case the fault was in the manipulation of the pieces in the dyeing operations, for which the dyer is to blame. We were once called to a mill in Worcester, Mass., to ascertain the cause of all their pieces being cloudy. Upon investigation, we found that the dyer was so far behind the fuller, that the pieces were piled up after they had been scoured, some of them having been scoured some two weeks previous (this was in the hot season), and had become mildewed and sour. The cloudiness was laid to the fuller, he not having scoured them properly, &c., but the fault was in the dyer not coloring them sooner. We will here give our views in regard to fulling and scouring pieces to be dyed any or all colors. After the cloths have been fulled to their proper width, scour them with soap for thirty minutes, then turn on warm water for about twenty minutes, which will insure the starting up of the fulling soap, and creating a good *lather.* After which, turn on the cold water, and let it run until it is clear as the cloth runs through the rolls. In regard to the kind and amount of soap to be used, every fuller and finisher has his own particular views, and no doubt thinks that the soap he uses, and the amount, is the very best, for which reason we

will not attempt to state our own particular views in relation to the soap or amount of it to be used, but will merely say that no matter whose make you use, be sure that it is all washed out from the cloth before it is sent to the dye-house.

After the pieces are thoroughly scoured, they should be well gigged on a dry gig, then they should be *cropped* on the shears, and if they are not required to have a lustre on them, they are ready for the dyer. But otherwise, they should be rolled up on rollers and steamed, by being laid horizontal in the steam-box, then cold water run into it and the steam turned on. Boil them from four to six hours, draw off the water, and take out the rolls, stand them on the end, and leave them until the cloth is cold; then take them off the rolls, run them once over the gig, and again roll them up, with the outside end of piece (previously) next to the roller, then steam as before. Perform this operation four or six times, reversing the end of the piece each time.

After the pieces are colored, they should be washed thoroughly with fuller's earth and water, in order to prevent their *crocking*. If the cloth is not *cropped* previous to being colored, the *nap* will act as a filter to the color, and prevent the color from penetrating the cloth; consequently, when the nap is afterwards cut off, the color is much lighter than expected or required, the best part of the color being taken off with the nap.

The earnest attention of the dyer is called to the above observations, and we would recommend him to study them thoroughly. The essential point to be observed in piece-dyeing is of as much consequence to the manufacturer as it is to the dyer, and it is his peculiar perogative, or that of the superintendent, to see that the pieces are delivered to the dyer in the very best possible condition for taking the color, of which condition the dyer is the only competent or legitimate judge. It is a duty that the dyer owes to himself, to his character and reputation as a skilful dyer, to insist upon those conditions being complied with and fulfilled at all times,

which he considers so indispensable to the ease and certainty of producing permanent and brilliant colors upon the goods; and it is for the interest of the manufacturer to sustain him at all times in these just and reasonable demands, by seeing that the pieces are given to the dyer in the condition he requires.

When all these conditions which the dyer requires are complied with, all other persons will be exonerated from blame for any mismanagement that might happen in the coloring of the pieces.

We reiterate the conditions the dyer should insist on being complied with: 1st, that the pieces are effectually fulled and scoured, and completely free from grease and soap; then entirely raised and gigged; well cropped down. These conditions are essentially the best in which the cloth can be placed in order to imbibe the color, and the dyer should not allow any of them to be neglected or dispensed with.

TREATMENT OF THE COLORS AFTER DYEING,

OR

THE FULLING AND SCOURING PROCESS.

The fulling and scouring of cloth containing fancy colors, does not have the attention given to it in comparison to its importance.

It is of little use for the dyer to exert his skill, and exhaust his care and patience to produce the best and most permanent colors, if they are afterwards to be spoiled, or nearly destroyed, through the ignorance or carelessness of those who may have the charge of the fulling and scouring. We are all aware that colors are not *unchangeable;* but most, and we might say all of them are *very susceptible* of change or alteration by the action of different operations and substances, as well as by heat and light, and we are not always to look at

what the color is when it leaves the dye-house, but what it will be when the cloth is finished and ready for the market.

There is no part of the manufacturing of the fabric that is so injurious as the operation of fulling and scouring the woven fabric, and it is upon this particular process that we wish to comment; for the most injury to colors can be always traced to the fulling and scouring. We do not mean to say that the operation of gigging will not impair the colors; hard gigging will often strip the color. We know that the operation of fulling will impair the color by the heat and friction caused by this operation, independent of anything else, and from the effects of this the finisher should be exonerated from all blame. Too hard or too heavy steaming will injure colors, especially such colors as chemic greens, and a number of the aniline colors. But it is the injudicious use of alkalies and strong alkaline soaps that are often used for fulling and scouring, that have the most destructive effects upon colors, and for this the person who has the charge of the finishing is in the greatest measure responsible. Soap that contains an excess of alkali will not only change the hue, but, by the heat and caustic nature of those articles, will dissolve a portion of any color we may place upon wool or cotton (but more particularly colors upon cotton), and, in most cases, will entirely destroy them. These destructive effects can be obviated, and it is an imperative duty of the overseer of finishing, as well as the superintendents, to see that these effects are avoided. We have known such an excess of soda-ash being used in the scouring-soap, that not only were fancy colors completely destroyed, but chrome-blacks were changed to a deep plum-color. The great fault of fullers is in making strong alkaline solutions for scouring out the goods after they have been fulled; but the idea is an erroneous one, and no intelligent fuller would do it, as a weak soap will scour out all the grease or oil there is in them just as well, and better, than a strong alkaline soap; besides, the weaker soap will leave the goods in a softer and more pliable state, and the colors will be

brighter and clearer. The alkali used in scouring should be of just strength enough to combine with the soap that was used to full the cloth and start the oil used for the previous operation of carding, and anything more than that is a waste of alkali, and an injury to the fabric and color.

An alkaline soap of uniform strength should at all times be maintained, and is at all times required; also, one kind of soap should be purchased, and then the fulling and scouring will be done with ease, certainty, and economy, and the preservation of the colors will always be insured.

In making scouring solutions, the overseer of the finishing should always see that each making is of the same strength as the previous one (which is easily ascertained by using a thermometer), and when using it, he should be sure that it is always of the same temperature as regards heat, for the higher the temperature is, the more will the colors be injured, besides causing the cloth to feel more harsh.

As regards the fulling soaps, there are two things very essentially necessary in their combinations.

First. A perfect freedom from all uncombined alkali.

Second. A uniformity of composition in the given quantities of its constituent parts, in each and every separate making.

There is not only a difference in soaps made by different soap manufacturers, but in soaps made at different times by the same manufacturer, which is the cause of some of the difficulties the fuller has to contend with. The cause of these differences in soaps originates from the fact that there are but few soap-makers that know what kind of soap is wanted for fulling and scouring purposes, or how to combine the alkali with the fatty matters they employ, in a just and chemical proportion. Neither are they aware that uniformity of the soap is indispensably requisite in order to produce the same effects and results at different and distant times.

There is but one soap manufactory that we know of, that steadily and systematically adheres to the above-mentioned

requisites in making soaps for fulling and scouring cloth, either in the white, for piece-dyeing, or for cloth of different colors, and that is the Holbrook Manufacturing Company of New York, 62 Church Street, they being qualified, both by information and large experience, to make an article of soap that will answer all the requirements of this branch of manufacturing cloth, their soaps being *always uniform;* and the alkalies employed are so blended, neutralized, and combined with the oily or fatty substances used in making their different kinds of soap, that it is almost an impossibility for them to injure the most delicate color. Their soaps are exceedingly well adapted for fulling and scouring colors made from the different aniline dyes; and we have often heard finishers assert that they never used so good a soap for fulling and scouring purposes, and that they would use no other if it were possible to get theirs, for it always came to them of the same quality and uniformity, and that it left the goods in a softer and more pliable condition than it was possible for a greater part of the fulling soaps now offered in the markets. Their increased sales prove their popularity and the high esteem in which they are held by our best manufacturers.

MANUAL OF OPERATIONS IN THE DYE-HOUSE.

Every dyer having his own particular method or way of doing work in the dye-house, what we may say in regard to the operations will perhaps be of no account; yet we should not feel as if this work were complete unless there was something said upon the manipulations of the dye-house. In the first place, have the wool scoured clean (see article on wool-scouring) the day before it is to be colored, so that it may drain well and evenly; then shake it up loosely in front of the tub in which it is to be dyed, pulling apart all the hard and twisted lumps, so that it may take the color evenly when it is

thrown into the tub or vat; leave the tub low enough in water, so that after the dyestuffs have boiled the proper length of time you can run in water enough to cool it down to 170° or 150° Fahr., at which heat we think it best to commence coloring any color; and, if on cloth, at a lower temperature than that; then throw in the wool loosely, expeditiously get in the poles and pole it well for ten or fifteen minutes, turn on the steam and bring it to a boil as soon as possible, which continue for one hour or one hour and a half, or as the recipes specify. Do not boil the wool too hard, but give it steam enough to keep it on the *spring* of the boil only. After it has boiled three-fourths of an hour, put the poles in again and pole it enough to change the position of the wool a little, which will prevent it from *stringing* or *twisting*. If the color is one that requires *saddening*, put such chemical salts as you intend to *sadden* with into a barrel or some convenient vessel, pour some of the liquor from the dye-tub into it to dissolve the salts; after they are all dissolved, throw it on slowly, a little at a time, while the men are poling it up. We think this is a better plan than to throw it on in the solid state, as you can get the saddening on more evenly by having the salts in solution.

In making colors that are prepared, or when the mordant is put on before the coloring-matter, they should be prepared in the afternoon, so that it may have time to lie a few hours in the preparation-liquor before it is drawn off. It is more important that the wool should lie in the preparation-liquor a longer time than in the coloring-matter. It was formerly the universal practice to wash the wool after was prepared, before entering it into the dyeing-bath, but we do not think it absolutely necessary, provided the wool has had a chance to drain well before it is thrown into the dyeing-liquor; yet it would be an excellent plan to extract the wet portions of the wool before coloring it. After it is prepared it should be again shaken up before putting it into the coloring-liquor, the same as for the first process. After the wool is colored it

should be washed off in the rinse-box, if it is possible to do so; but do not let it roll around in the box much, as it strings or felts the wool, which causes it to card badly.

There are no rules without some exceptions; therefore any variations from the plans generally adopted in dye-houses you will find specified in the recipes requiring such deviations.

ON THE TREATMENT OF THE DYESTUFFS IN THE DYE-TUBS.

The dyestuffs come to the dyer either in a chipped or ground condition, and the economy of dyeing depends upon the treatment they receive to extract all the coloring-matter from them; and to do that we should, in the first place, after the tubs or kettles are emptied, sëe that they are cleaned out and washed, in order that no remains of the former dye are left in it, as any portion of the metallic salts, alum, &c., have a tendency to prevent the coloring-matter of the dyestuffs being extracted, and especially from the hard, resinous woods, such as camwood, barwood, sanders, &c., which refuse to give out all their color if ever so little of these salts are in solution in the liquor. Next, use the coarsest bagging you can get for boiling out the chipped dyewoods; do not put too much into them, nor have them tied too far from the end, but leave all the space in the bags that you can, so that the inclosed chips can change their position by the boil; suspend the bags on a stick laid across the dye-tub. If you have a color that should require nothing but ground dyestuffs, boil them out in a separate vessel — a barrel, for instance — and take the clear solution and put it into the dye-tub; half an hour's boil is sufficient for the ground woods; should you not have the convenience for boiling them out, then throw them into the dye-tub loose, but do not put them into bags, because they will be so solid and compact in the bags that it will be

almost an impossibility to extract the coloring matter from them.

If you are making a dye that requires both chipped and ground dyestuffs, you can then mix them together and boil them in bags, but in this case it will take more of the ground dyestuff than it would if they were thrown loose into the tub; by mixing the ground with the chipped, or boiling out, as above, you have the advantage of your wool being clean and free from dust.

We have often sprinkled the ground woods upon the wool before entering it into the dye-tub, that is, such as camwood, barwood, and sanders; you can adopt either of the above plans. The right plan, however, is to have no loose dyestuffs in the tub if it is possible to avoid it, as it gets among the wool, it fills up the cards, and it will not card or spin as well as it would if we kept the ground dyewoods out, for which reason we prefer the boiling out of these woods in a separate vessel and using the clear solution; but this plan is not always practicable; but in all cases, if it is possible, have the coloring solutions a clear *aqueous tincture* of the coloring matter only.

If you should have a color that is done by one operation, that is, a color that requires the coloring matter and the mordant to be all in one bath, you must boil out the dyestuffs first, then dissolve such chemical salts as you intend to use, in a pail, and pour it into the tub, then throw in the wool and pole up as soon as possible, putting on the steam and bringing to a boil as quickly as can be.

Lastly, in preparation-colors, when the chemical salts are employed as the mordant, all that is required is to dissolve them in a pail, or throw them into the tub and boil until you think they are dissolved. Any variation from the above plans you will find stated in the recipes requiring it.

One hour and a half boiling is all that is required for the chipped dyestuffs; but if you have ground and chipped mixed in the bags, then boil them two hours.

THE DIFFERENT PROCESSES OF DYEING.

"There are but three general methods or processes of dyeing wool or woolen goods (in cotton-yarn dyeing the same methods are also employed), or, in other words, distinct plans of combining colors in a chemical manner with the animal fibres (or vegetable). We shall attempt to give an account of them, with an explanation of the theory upon which these combinations take place."

"The first is described as that process wherein all the materials that enter into the composition of color are mingled together in one common solution or bath, and applied to the wool or cotton at once, by one or one and a half hours' boil" on wool (but on cotton, either in a cold or lukewarm bath).

First Process.

"If, in a clear solution of logwood, fustic, or other kind of dyestuff, you pour another solution of any metallic or earthy salt, such as copperas, alum, &c., you will observe, when this mixture takes place, the solution becomes *broken*, and a flocky or curd-like matter is formed, which gradually settles to the bottom of the vessel in which the mixture was made. This precipitate is the color, which in this first method of dyeing you apply directly to the wool by about one or one and a half hours' immersion and boil."

"This experiment exhibits in the clearest manner, the formation of any color we wish to combine with the wool; actually impressing on the visual organs the mysterious operations of the invisible mechanism of dyeing; for we really and positively *see* the union take place between the coloring principle and the earthy and metallic salt; the combination of which two substances forms or makes the color we intend to place upon either the wool, silk, or cotton."

"It also explains the true theory of the formation and constitution of colors, showing them to be a chemical compound, the elements of whose composition are an undefined coloring

principle, distributed abundantly through the vegetable and mineral kingdoms, and an earthy substance, or metallic oxide."

"Although this flocky substance (which is new-formed color) gradually subsides to the bottom, and leaves the liquor but slightly tinged, yet it is not an insoluble precipitate, but is partially soluble in water, and more particularly at a boiling heat; and on this slight degree of solubility rests the property it possesses of forming a chemical union with the material to be colored. If it formed an insoluble precipitate, no chemical combination could take place by this method of dyeing; because the wool, cotton, or silk being boiled in a liquor containing nothing but an insoluble powder, no chemical action could take place between them, and the wool, cotton, or silk would be merely *stained*, and this insoluble precipitate only adhering to it, and that with but a slight mechanical force, the simple operation of washing in water would be sufficient to remove it."

"As said before, this partial solubility of the color is the cause of its union with the wool, cotton, and silk, for upon immersing these substances in the liquor, it immediately seizes the part held in solution (the affinity between the color and the material to be colored being greater than between the water and the color); the water thus exhausted of the color which it held in solution, will now dissolve another portion of the color, which is again taken up by the wool, silk, or cotton; and so on, portion after portion, until the whole coloring matter becomes combined with the material which is being colored, having all been dissolved successively by the water, before it could enter into a close combination with the fibre of the substance to be colored."

"This method of dyeing requires a rapid ebullition during the time of coloring, as the greater the heat and agitation given to the water, the more finely are the broad, flocky particles broken and cut up; and in proportion to the minute-

ness of the coloring molecules, so will be the intensity of the shade."

"Although this method of dyeing is more expeditious than either of the other two, yet we do not consider it equal to them, either in brilliancy or permanency of color."

"This plan is more generally used for yarn, flannels, and cloth, especially the finer colors; yet you will find it resorted to in several recipes for wool and cotton dyeing."

The Second Process.

"The second method of applying the color is known among dyers by the appropriate terms of *stuffing* and *saddening*, and its operations are performed in this manner:

"After the dyestuffs have been boiled sufficiently to extract their coloring matters, the wool is entered, and two hours' boiling given to it. This is the *stuffing* part of the process; and the wool acquires only a slight tinge of the color peculiar to an extract of the dyestuffs used in making the solution."

"Longer boiling than the above time is unnecessary, as all the color requisite to produce the best effects is, in that time, combined in the wool."

"The next step is the *saddening*, or giving to it the mordant, which consists of some chemical salt, such as copperas, blue vitriol, alum, &c.; the manner of doing which is laid down in the article 'On the Operations of Dyeing'" (which see).

"In the first part of this process, a combination is effected between the wool and the coloring matter, analogous to that which takes place between the astringent, or tanning principle, and the raw hide, in the process of tanning. Let us illustrate this:

"Make a decoction of logwood, or fustic, for instance, then pour into the decoction a weak solution of gelatine, and you will perceive that a precipitate falls, of the color of the solution of the dyestuff employed, and a large amount of color has been abstracted from the decoction. This precipitate is

the glue and the coloring matter, which, by their mutual affinities, have formed a compound that is insoluble in water. Of a similar nature is the union resulting from the boiling of wool in the solution of most of the dyestuffs."

"In the *saddening* part of the process, both the coloring-matter and the wool having a strong affinity for the metallic or earthy salts; these are drawn by them with an increased attraction, and a triple compound, of animal matter, the coloring-principle, and the mineral base of the color, is formed, which, being held together by virtue of the three separate forces, offers such a resistance that boiling water cannot disunite them."

"Precisely similar are all unions of coloring-matter with wool, no matter what process may have been employed to effect it."

Third Process, or Preparation and Finishing.

"This is exactly the reverse of the second method, and consists of two distinct stages; in the first of which the wool is boiled for one and a half or two hours (see article, Operations of Dyeing), in a solution of the metallic or earthy salts that form the mordant, or base of the color you wish to produce. These have a strong tendency to unite with the wool, inasmuch that on coming out of the preparation it is generally tinged with the shade peculiar to the oxide of the metal used; and so tenacious is its power of adhesion, that, after the coloring-matter originally used shall have faded off, or undergone a material change, the property of the mordant remains unaltered, for it will absorb fresh coloring-matter as readily as before."

"In the second part of this method, or process, a bath of clean water is prepared, in which the dyestuffs are boiled until all the color is extracted; in this, the prepared or mordanted wool is dyed up, occupying one and a half or two hours' time in boiling. In this case, the wool and the mordant both having an affinity for the coloring-matter, their joint

forces attract it from the water with such violence that it is immediately and rapidly united with them, and the color is soon brought out. For this reason, the finishing part of the process requires expert workmanship, in order to have the wool evenly dyed."

"The same colors, produced by this process, are more brilliant and permanent than by either of the other processes, but this process requires more time and labor, and is also more expensive than either of the other methods."

"From these observations, it will appear that there can be but three plans of combining color with wool."

"*First.* By applying the color at one operation.

"*Second.* By combining the coloring-matter with the wool, and then giving it the mordant.

"*Third.* In fixing the mordant upon the wool first, and then applying the coloring-matter afterwards." — *Gibson's System and Science of Colors.*

COTTON-YARN DYEING.

In dyeing cotton-yarns, the first operation is to boil out the yarn in a soda-ash solution. This is sometimes done under pressure ; that is, the yarn is put into an iron vessel. The soda-ash solution is then poured in, and the aperture of the cauldron is closed and screwed down perfectly steam-tight, the steam-valve is opened to allow it to enter the cauldron, to which is attached a safety-valve, with a weight attached to the lever. This weight can be adjusted according to the amount of pressure required ; but in a greater part of the dye-houses where cotton yarn or thread is colored, the yarn is placed in one of the tubs and slats laid across upon the yarn, with weights laid upon them, to keep the yarn under the liquor ; steam is then let on, and the yarn boils from two to five hours the day before it is to be colored. For light and delicate

colors the yarn is often bleached before it is dyed, in order to obtain a more clear and brilliant color; the bleaching is effected by first boiling out the yarn as above described, then passing it through a chloride of lime solution, then washing it from this in cold water; it is wrung out and passed through a bath of cold water to which has been added a very small quantity of chemic and oil of vitriol (some dyers use a little soap in this bath); it is then washed again, and is now ready for the coloring processes or to be dried for white.

A great deal depends upon the handling of the yarn in the operation of coloring it, in order to obtain even colors, and most especially in coloring greens; the yarn should be wrung three times, and *well wrung*, and shaken out, and those colors that have to be *spirited* before they receive the coloring-matter, should be washed out in warm water instead of cold before they are immersed in the dyeing-bath, and in each bath they should have an odd turn; that is, they should have either three, five, seven, or nine turns. This is essential in order that they be colored even. By giving these odd turns each end of the skein is subjected to the same length of time in the different solutions.

Care should be taken that the drying-room is not kept at too high a temperature of heat, and that the yarn is wrung out as dry as possible before it is hung up in the drying-room, for this reason: the yarn being wet when it is hung up, the heat in the dry-room will subject the colors to a hot *vapor-bath*, and the colors will be partially destroyed by the joint action of the heat and steam arising from the wet yarn, for heat acts upon colors on cotton differently, when the heat in the drying-room is dry, and when it is moist, which shows the necessity of giving close attention to the drying of the yarn, by hanging far enough apart to allow the free outlet of the moisture. Even the same dyestuffs fixed upon the cotton yarn, but by different mordants, are affected differently by heat, whether moisture be present or not. Greens and Prussian blues are affected the most if hung up wet, and then raising

the temperature of the room to a high heat; the Prussian blue would, under these circumstances, entirely fade away if the temperature should be raised to 212 degrees, Fahr. The same colors fixed upon silk and cotton, placed in the drying-room, being equally moist are affected oppositely, the color upon the silk not being affected, whilst that upon the cotton is completely destroyed. This is particularly the case if the color fixed upon them be a safflower-pink.

In working the following recipes for coloring cotton-yarn, the explanation of the technical terms used will be found in the glossary at the latter part of this book, as will all the terms used throughout the work.

In coloring the safflower-pinks, the yarn must be first bleached, but not blued; that is, in bleaching the yarn, there *must not* be any *chemic used.*

After they are colored, the yarn must be dried in a *cold room*, or in a shed where the sun's rays will not reach the yarn. And in coloring these kinds of pinks, everything about the boxes must be clean; yet there is no damage done them if colored in the boxes where reds, or the scarlet shades, have been colored: provided you wash the boxes out well with clean water. If you were to color 100 lbs. yarn safflower-pink, and use three pints of extract safflower, and dry it in a room that is heated, and then color 100 lbs. yarn with two pints of extract of safflower, and dry the yarn in a cold room, you would find that the latter was the best color. So we see the propriety of attending to the manner of drying this kind of a pink on cotton-yarn.

RECIPES FOR COTTON-THREAD.

The following recipes are colors that have been produced upon thread within the last two years, and are the colors mostly in demand at the present time, and a great many of them are colors employed for warp that were for goods that

require the fulling and scouring process in their manufacture; therefore they are termed *permanent* or *fast*.

Purple.

25 lbs. cotton-yarn. Steep the yarn overnight in
8 lbs. Sumac. Wring it out. Then

In a bath of clear water, add enough nitro-muriate of tin to indicate 2 degrees by Twaddle hydrometer. Work the yarn in this solution twenty minutes; wring out; wash, and wring three times (that is, wring three times). Then in another fresh-water bath, dissolve 4 lbs. extract of logwood. Work the yarn in this for three-fourths of an hour, at a boil-heat. Then raise the yarn, and add one lb. sal-soda. Enter the yarn again, and turn seven times, or more if the shade is not dark enough. The sumac-bath should be about 100 degrees F.; but the spirit-tub is worked *cold*. The spirit-solution can be kept for other colors which require the spirit, by adding to it enough nitro-muriate of tin to bring it up to the desired standard, — 2° Twaddle.

Fast Purple.

25 lbs. cotton-yarn.

Boil out five lbs. sumac for a half hour. Cool down to 170° F. Enter the yarn; give five turns; then lay it down under the liquor overnight, or at least for four hours. Take out and wring the yarn.

Second. Dissolve two and a half lbs. stannate of soda in a box or tub of boiling water. Enter the yarn, and give seven turns. Wring the yarn; wash it off, and wring again.

This bath can be kept for further use by adding two lbs. of stannate of soda for every twenty-five lbs. of yarn.

Third. Dissolve in a bath at 140° F., three and a half ounces of Hoffmann's B Bs. Enter the yarn, and give five turns. Bring the bath to a boil as soon as possible.

If a redder shade is wanted, use the same amount of Hoffmann's R R R instead of the B Bs.

Before entering the yarn into the dye or third bath, add two quarts of a mordant made thus:

Two lbs. alum; one lb. brown sugar of lead. Dissolve these in three gallons of water. When dissolved, add water until it shows 12° Twaddle.

Silver Drab.

20 lbs. cotton-yarn:
4 ounces Ground Logwood,
1 quart of Lime-water (clear).

Boil out the logwood for fifteen minutes in a convenient vessel. Then pour it into the dye-tub, and add the lime-water. Give the yarn nine turns. Take out and wash it off. This is a *cold bath*.

Another Silver Drab.

20 lbs. cotton-yarn:

Boil out one-quarter lb. nutgalls. Add the clear solution to the dye-tub of cold water. Give the yarn seven turns in this. Then raise it out, and add one-half gill of nitrate of iron (iron liquor). Enter the yarn again, and give it five turns. Take out and wash the yarn off.

Light Drab.

50 lbs. cotton-yarn:
2 lbs. Cutch.
1 lb. Extract Fustic,
1 lb. Nutgalls.

Boil out the nutgalls, and dissolve the cutch and fustic. Then enter the yarn, and turn it for half an hour at a boiling heat. Raise out the yarn, and add to the solution one-quarter lb. of copperas. Cool down the bath to 165° F. Enter the yarn, and turn for ten minutes. Take it out and wash off.

Another Light Drab.

50 lbs. cotton-yarn:
1 lb. Cutch,
$\frac{1}{2}$ lb. Sumac,
2 oz. Extract Fustic.

Proceed as for the other light drab. Give the yarn five turns, *smartly*, at a boiling heat; then take it up and add to the solution, one lb. copperas; re-enter the yarn, and give five turns at boiling heat; take out and dry.

Linen Color.

50 lbs. cotton-yarn:

Boil out twenty lbs. sumac; when it is settled, add the clear liquor to the dye-tub; heat it up to 130° F. Enter the yarn, and give it five turns; then lay it down in the bath until next morning; take it out and wash and wring out.

Tan Color.

50 lbs. cotton-yarn:

Boil out six lbs. cutch; enter the yarn at a boiling heat, and turn it for twenty minutes; take it out and wring it. Keep this bath for further use. In a tub of water dissolve
1 lb. Blue Vitriol,
6 oz. Chrome.

Enter the yarn at 150° F., give it five turns, take it out, now add to the first or cutch bath six ounces of chrome; after it is dissolved enter the yarn at 160° F., and give it three turns; take out and wash it off, and dry.

Another Tan Color.

50 lbs. cotton-yarn:
$1\frac{1}{2}$ lbs. Sumac,
$\frac{1}{2}$ lb. Extract Logwood,
6 lbs. Cutch.

Boil these until all are dissolved. Enter the yarn and turn it for one-half an hour, at a boiling heat, take it out. Then

in a fresh bath use one lb. blue vitriol, one-half lb. chrome, one-quarter lb. copperas. When dissolved, enter the yarn at 150° F., and turn it for fifteen minutes; take it up; now add to the first bath two ounces of chrome, and turn the yarn in this for fifteen minutes, at 130° F. Take out, wash off, and dry.

Dark Blue.

50 lbs. cotton-thread:

Add to a cup of cold water,
6 pints Nitrate of Iron,
2 lbs. Tin Crystals.

Stir or rake up the tub, enter the thread or yarn, and turn for twenty minutes. Take out the yarn and wash it off well. Then in a second bath of fresh water, add

10 lbs. Yellow Prussiate of Potash,
1 quart Muriatic Acid.

When the prussiate is dissolved, enter the yarn, and turn for twenty minutes. Take it out, and pass the yarn into the first bath (nitrate of iron bath), giving seven turns. Take it out and pass it through the prussiate tub, giving seven turns. Take out and wash off.

If you desire a *very dark blue*, make a fresh bath with four lbs. extract logwood, one lb. chemic, three-fourths lb. alum. Run the yarn in this, after the above operations, for twenty minutes. Take it out and wash off again. N. B. These are all cold baths.

Medium Blue.

50 lbs. cotton-thread:

2 quarts Nitrate of Iron,
2 lbs. Tin Crystals.

Turn the yarn for twenty minutes, then take it up.
In a fresh bath dissolve

2½ lbs. Yellow Prussiate of Potash,
1 pint Muriatic Acid.

Enter the yarn and turn for twenty minutes. Take it out and pass it into the nitrate of iron bath, then back to the prussiate tub, turning it for twenty minutes in each bath, washing it off after the last time through the prussiate bath.

These baths, like those for dark blue, are worked cold. These blues should be dried in a very dry atmosphere. They should be wrung out as dry as possible, before being hung up to dry.

Light Blue.

50 lbs. cotton-yarn:

First bath. 1 quart Nitrate of Iron,
1 lb. Tin Crystals.

Second bath. $1\frac{1}{2}$ lbs. Yellow Prussiate of Potash,
$1\frac{1}{2}$ gills Oil of Vitriol.

Proceed as in the operations of the above blue. Lighter shades can be obtained by diminishing the proportions in the proper ratio.

Prussian Blue.

30 lbs. cotton-yarn:

First bath. Add two quarts of nitrate of iron to the tub of hot water. Enter the yarn, and give nine turns, at a boiling heat. Take out and wring.

Second bath. To the tub of cold water, add

$1\frac{1}{2}$ lbs. Yellow Prussiate of Potash,
4 oz. Tin Crystals,
4 oz. Oil of Vitriol.

Enter the yarn and give nine turns. Take out and wash off, and wring out the yarn.

If the shade is not dark enough, give it five turns more in the first or iron bath. Then wring out, enter into the second or prussiate tub, and give five turns. Take out, wash off, and wring the yarn out.

German Blue.

50 lbs. cotton-yarn:

To four gallons of water, add

$4\frac{1}{2}$ lbs. Wheat Starch,
$1\frac{1}{4}$ lbs. Chlorate of Potash,
$1\frac{1}{2}$ lbs. Chloride of Copper,
$2\frac{1}{2}$ lbs. Chloride of Aniline.

For every two lbs. of yarn, add nine quarts of the above mixture to a tub of cold water. Enter the yarn in this, and give six turns. Take out and hang up to dry and age for two days. Then wash off the yarn, and pass it through a bath containing sufficient yeast or any other ferment to remove the starch. Wring out the yarn from this bath, and enter it into a tub of cold water, with enough oil of vitriol added to it so that it is just perceptible to the taste. Give five or six turns. Take out, wash off. Then give five turns in tub of cold water, to which has been added enough soda to mark $2\frac{1}{2}°$ Twaddle. Take out, wash off, and dry.

Dark Prussian Blue.

50 lbs. cotton-yarn :

First bath. $1\frac{1}{2}$ pints Nitrate of Iron,
$\frac{1}{2}$ lb. Tin Crystals.

Enter the yarn, and turn for twenty minutes. Take out and wring the yarn.

Second bath. Add to the clear water, one lb. yellow prussiate of potash (previously dissolved), and one gill muriatic acid. Enter the yarn, and turn for twenty minutes. Take out, re-enter into first bath, proceed as for the first time, then re-enter the second bath, and proceed the same. Take out and wash off the yarn well, and wring it out.

Third bath. Dissolve

4 lbs. Extract Logwood,
$\frac{1}{2}$ lb. Alum,
$\frac{3}{4}$ lb. Sulphate of Indigo (Chemic),

and add them to a tub of cold water.

Enter the yarn, and turn for twenty minutes. Take out and wash off.

All these baths are cold-water ones.

Chrome Yellow.

25 lbs. cotton-thread:

First bath. Ten ounces chrome. Enter yarn and give seven turns at 100° F.

Second bath. Ten ounces white sugar of lead. This is to be cold. Give seven turns; that is, give seven turns first in the second bath, then seven turns in the first bath, then seven turns in the second bath, then wash off the yarn and dry.

Dark Slate.

25 lbs. cotton-yarn:
 1¼ lbs. Nutgalls,
 7 oz. Extract Logwood.

Boil these for fifteen minutes, then cool down the bath to 160° F. Enter the yarn and turn for half an hour, take out the yarn and add to the solution half a pound copperas, re-enter the yarn and turn for fifteen minutes at 160°, take out and wash off, or not.

Medium Slate.

50 lbs. cotton-yarn:
 6 oz. Extract Logwood,
 ½ lb. Sumac.

Boil these articles for twenty minutes, then cool down the bath to 160°. Enter the yarn and turn for twenty minutes, take it out and add six ounces copperas, re-enter the yarn and turn for twenty minutes at 100° F., take out the yarn and wash off, wring out and dry. After washing off for the drying, wring out or extract the yarn in all cases.

Light Slate.

50 lbs. cotton-yarn:
 2½ oz. Extract Logwood,
 3 oz. Sumac.

Boil these for fifteen minutes, then cool down to 160° F., enter the yarn and turn for twenty minutes, take out the yarn

and run off the liquor enough so that by filling up again with cold water the temperature will be reduced to 100° F., then add two ounces copperas; re-enter the yarn and turn for twenty minutes; take out, wash and wring.

Green.

50 lbs. cotton-yarn:

Give the yarn a blue bottom, by dyeing it a medium Prussian blue (see recipe for medium blue). Then, in a fresh bath, dissolve two and a half pounds extract fustic; turn the yarn for fifteen minutes at a boil; then take out the yarn and add to the solution

2 lbs. Alum,
2 lbs. Tumeric.

Boil these for ten minutes, then re-enter the yarn and turn for half an hour; take out and wash off.

Unless the yarn for greens is handled well, they will generally be uneven, so great care and attention must be given to the manipulations in order to avoid this difficulty.

Green.

20 lbs. cotton-yarn:

First. Give the yarn a good blue in the copperas-vat, by coloring it a Prussian blue (see Prussian blue recipes); wash off the yarn.

Second. To a tub of cold water, add acetate of alumina enough to indicate 6° Twaddle; enter the yarn and turn for fifteen minutes; take out and wash off in warm water.

Third. Boil in a bag eight pounds quercitron bark for three-quarters of an hour; cool down the solution to 190° F. Enter the yarn and turn for fifteen minutes; take out the yarn and add to the liquor one pint of red liquor, or one pound of alum; re-enter the yarn and give five turns; take out, wash off and wring the yarn and dry (see remarks on drying greens). A little chemic in the bark liquor will make a little brighter color.

Methyl-Green.

10 lbs. cotton-yarn:

First bath. Steep the yarn overnight in one pound sumac; next morning wring out and shake open the yarn well.

Second bath. Dissolve one and a half ounces methyl-green crystals, and add to a box of water heated to 130° F.; stir it up well; enter the yarn and give seven turns, or until it will not take on any more color.

This bath can be worked hotter, but the color does not seem to go on so perfectly as it does at the above temperature. The sumac bath is worked cold.

Fast Green.

25 lbs. cotton-yarn:

First bath. Steep the yarn in five pounds sumac at 160° F. overnight; next morning wring out the yarn.

Second bath. Dissolve two and a half pounds stannate of soda in a box or tub of boiling water, enter the yarn and give seven turns, take out, wring, wash out the yarn and wring it again.

This bath, like the one for fast purple, can be kept for further use, by adding two pounds stannate for every twenty-five pounds of yarn.

Third bath. Boil in a convenient vessel four pounds quercitron bark, take the clear liquor and add to the bath. Dissolve three and a half ounces of iodine-green crystals and add to the bath. Enter the yarn at 140° F., and give five turns, bringing the bath to a boil as soon as possible, which should be done in half an hour; then take out the yarn and put it through the oil-bath at lukewarm heat (see oil-bath which is given with the recipes for black). This oil-bath softens the yarn. Before entering the yarn in the third bath, add two quarts of mordant (for making the same, see mordant under the recipe for fast purple).

DARK GREEN.

50 lbs. cotton-yarn:

First bath. 3 pints Nitrate of Iron,
2 lbs. Tin Crystals.

Second bath. $1\frac{1}{2}$ lbs. Yellow Prussiate of Potash.

Proceed as for blues. (See recipes for blue on cotton-yarn.) Then finish in a fresh bath of

$2\frac{1}{2}$ lbs. Fustic,
$2\frac{1}{2}$ lbs. Alum.

Boil the extract until it is all dissolved, then add the alum. Enter the yarn and turn for three-fourths of an hour at a boil; take out, wash off, wring, &c.

REDS.

In coloring reds with barwood, it should be thrown into the bath loose, as the barwood must be in contact with the yarn. The coloring-matter of barwood, when at a boiling heat, will easily combine with the spirits or compounds of tin which is upon the yarn, resulting in or forming an insoluble rich red color. For barwood reds, the yarn is first steeped in sumac, then impregnated with protochloride of tin ("spirited"), then, being put into a solution of barwood, what coloring-matter is held in solution the yarn will take up, and the water thus exhausted will then dissolve more of the coloring-matter in the barwood, and this will be again taken up by the tin, and so on until the tin upon the yarn is completely saturated with the coloring-matter; and when this is the case, the color is then at its highest and richest point, and it requires a large amount of skill and experience to know the exact moment when to take the yarn out of the bath. Having to throw the barwood into the bath loose, in order to obtain the best results, the yarn becomes filled with the particles of barwood, which causes the yarn to reel off very badly, frequently breaking, &c. To obviate this, there should be a frame made to fit the dye-tub, and on this frame there should be a piece of coarse cloth fastened; there should

be cleats in the inside to hold this frame a certain distance from the bottom of the tub; then, when ready to color, throw in the required amount of barwood, put in the covered frame and button, or fasten it down; then pour in or fill up the tub with water, put on the steam and boil for half an hour, or as the recipe may direct; then enter the yarn, handling it at boiling. By doing this the yarn is free from dirt and chips.

Barwood Red.

50 lbs. cotton-yarn.

First bath. Twenty lbs. sumac. Boil it out, and, when settled, take the clear solution and add it to the dye-tub; heat it to 100° Fahr., enter the yarn and give five turns, then lay it down under the liquor and leave there all night; next morning take out and wring.

Second bath. Add to this enough nitro-muriate of tin to indicate 2½° Twaddle (see article, tin solutions), enter the yarn and give it nine turns, take it out and wash off. This bath is to be cold, and can be kept for further use by adding enough more spirits to indicate the strength required.

Third or finishing bath. 45 lbs. Barwood,
8 lbs. Hypernic-wood.

Follow the plan laid down in the preceding page in regard to the barwood. Turn the yarn for three-fourths of a hour at a boil.

We will give a few processes for coloring Turkey-red upon cotton-yarns, although we doubt whether these recipes will be of any benefit to the majority of cotton-dyers, as they are too costly and require too many operations and manipulations for most of purposes for which cotton-thread is now wanted.

Turkey-Red.

25 lbs. cotton-yarn.

First bath. Boil out the yarn in soda-ash (see directions for cotton-yarn dyeing). Steep in ten lbs. sumac overnight, at 100° Fahr.; next morning wring out the yarn.

Second bath. Add to clear water enough acetate of alumina (red liquor) to show 3° on Twaddle's hydrometer, enter yarn and give nine turns, take out the yarn and wash off. This second bath is a cold one.

Third bath. Dissolve one peck of sheep's dung, add it to the bath, and enter the yarn at a boil and turn the yarn for three-fourths of an hour.

Fourth bath. Add four lbs. of alizarine to the water heated to 150° Fahr., turn the yarn in this for two hours, take it out and wring, age it for five days; that is, lay it away for five days before finishing it off. Then in the

Fifth bath. Put in two lbs. soda-soap; after it is all dissolved, cool down the bath to 190° Fahr., enter the yarn and turn for one hour, take it out and wash off in warm water, wring it out and dry.

This is the only method that we know which is used in this country. The most simple method, and of the least expense and trouble, which is used in Europe, is the following one, which is a French recipe:—

Red.

10 lbs. cotton-yarn.

"Steep in a bath, overnight, of two and a half lbs. sumac; next morning take out the yarn and wring it, add two oz. of tin crystals to the sumac liquor, enter the yarn and turn for half an hour, take out the yarn and wash off and wring.

"Second bath. To water heated to 70° Fahr., add ten oz. white soap, and when it is all dissolved, enter the yarn and turn for twenty minutes, take it out and dry the yarn.

"Third bath. Add alum enough to indicate 6° on Baume's hydrometer, turn the yarn in this for half an hour at 70° Fahr., take out the yarn and wring well.

"Fourth bath. Two and one-half pounds garancine; enter the yarn in this and turn for one hour at a boil; take it out and wring.

"Fifth bath. Add bleaching powders enough to show 1°

Baume, turn in this for fifteen minutes, take out the yarn and wash off well, then dry."

Red.

100 lbs. cotton-yarn.

First bath. Boil out for half an hour, 30 lbs. sumac; let it settle, draw off the clear liquor, and add to it a bath of water at 70° F., enter the yarn and give five turns, then sink it under the liquor and let it remain there all night; next morning take it out and wring it.

Second bath. Add enough nitro-muriate of tin to show 2½° Twaddle (see recipe for making nitro-muriate of tin); give the yarn five turns in this, then sink it under the liquor; let it remain one hour, take it up, wash it well, and wring as dry as possible.

Third bath. Boil in bags for one and a half hours, forty lbs. Brazil-wood; take out the bags, enter the yarn and give seven turns, take it out, and add to the bath three gills of muriate of tin (see recipe for making it), re-enter the yarn and give five turns, take it out and wash off in cold water.

If you have not the Brazil-wood, use 50 lbs. of Hypernic-wood instead, but the hypernic does not give so clear and bright a red as the Brazil-wood does.

We will here remark, that in coloring reds on cotton-yarn, if you will, after washing off and wringing out the yarn from the spirit-tub, or bath, pack it down upon a *scray*, and cover it over with a damp sheet or cloth until the next day, you will obtain a more intense and brilliant red than you would otherwise.

Also, in coloring these reds, if you should want them more towards the scarlet shade, use four or five pounds of fustic along with the sumac.

Red.

This is the nearest approach to a Turkey-red of any, considering the few operations it requires to produce the color,

and it is the brightest and clearest red made, except the *real* Turkey-red of Europe.

20 lbs. cotton-yarn.

First bath. Steep in twelve lbs. sumac overnight; next day wring out. This bath must be cold.

Second bath. Add to cold water,

3 lbs. Acetate of Alumina, at 3° Baume,

1 lb. Acetate of lime, at 3° Baume.

Give the yarn seven turns in this, take out, wash it off, wring out and shake the yarn well out, then enter in the Third bath:

1 lb. Purpurine,

1 lb. White Soap.

Boil these for half an hour, then cool down with cold water to 130° F., turn the yarn in this for half an hour, raising the temperature to 190° F.; take out, wring the yarn.

Fourth bath. Two lbs. tin crystals in water, at 160° F.; enter the yarn, and turn fifteen or twenty minutes; take out and wash off. This bath brightens the red, yet by omitting it the color is very beautiful.

The Turkey-red process is such a complicated one, that there is no dyer in this country would be at the trouble of performing the various operations through which the yarn has to pass; neither do our manufacturers want to be at such an expense as it would necessarily be to color their yarns and threads this particular shade of red. However, there may be some one who will purchase this book, that would like to know the process by which such a beautiful red is obtained; therefore, for their information, we will insert a recipe used by Schrader, one of the best of German dyers.

25 lbs. cotton-yarn.

Fill a tub with soda liquor, of 1° Baume strength, boil the yarn in this an hour, and leave it in the solution for four hours. This is called the first bath.

Second bath, or cow-dung bath. Cow-dung, five lbs.; soda-ash liquor, 20 lbs., at 80° Baume. Mix the two together,

and leave for ten or twelve hours; then add eighty lbs. of water, eighty lbs. soda-ash liquor, at 4° Baume; then filter it through a fine sieve, and add to the clear solution four and a half lbs. olive oil. Stir until it is completely united, then enter the yarn and turn for half an hour; take it out and wring, then leave the yarn for twelve hours to age.

Third, or white bath. Soda-ash liquor, 9° Baume; add two lbs. olive oil. (By the soda-ash liquor is meant, add enough soda-ash to the water you have in the tub, so that it will indicate 3° by Baume's hydrometer). When these are incorporated, add to it seventy lbs. soda lye, at 2° Baume. Now enter the yarn in this, and give half an hour's turning; take out the yarn, wring and dry it.

Fourth bath. Add enough sal-soda to this bath to stand at 1° Baume, turn the yarn in this solution for fifteen minutes, take out, wring, and leave it for six hours.

All the above baths are to be worked cold.

Fifth, or galling bath. Boil for three-quarters of an hour, in 80 lbs. of water,

2 lbs. Nutgalls,
8 lbs. Sumac.

Strain it through a fine sieve, turn it into the tub, enter the yarn, and give five turns; then sink it beneath the liquor for ten hours. (This bath is to be at boiling heat when the yarn is entered.) After the ten hours have expired, take out the yarn, wring, and dry it.

Sixth, or alum bath. To sixty lbs. water, add six lbs. alum, half lb. soda-ash (pure), and half lb. chalk. Boil these until dissolved, then let it settle, and take the clear liquor and add it to the tub; enter the yarn, and turn until it is completely wet or saturated; wring out and dry.

This bath is to be lukewarm.

Seventh bath, purification from the alum. Dissolve one lb. chalk in the tub of cold water, turn the yarn in this for half an hour, take it out and wash off.

Eighth, or Madder bath:

1 pail of Blood,
40 lbs. Madder.

Enter yarn in this at 175° F., raise the heat to a boil in one and a half hours, and boil half an hour, turning the yarn all the time; then take it out and wash off, preparatory to the raising process.

Ninth bath, Raising:

1 lb. Olive Oil,
2 lbs. White Soap,
160 lbs. Soda lye, at 2° Baume.

Work the yarn in this bath for twenty minutes, at 170° F.; take it out, and wring out.

Tenth, or Finishing Bath: To sufficient water, add

4 lbs. White Soap,
6 ounces Tin Crystals,
1½ ounces Nitric Acid.

Enter yarn and give seven turns, at a gentle heat; take out the yarn, wash off and dry.

Scarlet Red.

50 lbs. cotton-yarn.

Steep the yarn overnight in twelve lbs. sumac. Next morning, wring out, and give it five turns in the spirit-tub, at 2½° (Twaddle's) strength. Wash off the yarn, and wring out, and finish off with

45 lbs. Barwood,
5 lbs. Turmeric.

Proceed as for the Barwood Red.

Another Red.

50 lbs. cotton-yarn.

Steep the yarn, and spirit as for the above Scarlet Red. Wash and wring out. Then finish with

10 lbs. Barwood,
20 lbs. Ground Brazil-wood.

Proceed as for Barwood Red.

We omitted to state that the sumac and spirit tubs were used cold.

SALMON.

50 lbs. cotton-yarn.

First bath. 1 gallon Nitrate of Iron.

Second bath. 2 lbs Sal-soda.

Give the yarn seven turns first in the iron-bath ; then seven turns in the soda-bath. Wring out the yarn from each bath. Pass the yarn through each bath three times, and, the last time, wash it off before hanging it up to dry.

These baths are to be cold.

ANILINE, OR FUCHSINE RED (FAST).

30 lbs. cotton-yarn.

First bath. Give the yarn five turns in warm water, in which has been dissolved three lbs. of common soap. Take out the yarn, and wring twice.

Second bath. Boil out ten lbs. sumac in the box or tub. Enter the yarn, and give six turns. Take out. Enter into the

Third bath. To tub of cold water add one and three-fourths lbs. tin crystals. Give the yarn six turns. Take out, and wring and wash.

Fourth bath. Add to bath of water, at 120° F., three ounces magenta crystals. Enter the yarn, and give seven or nine turns. Take out and wash off.

We can obtain a bluer shade if we wish, by bringing the fourth, or finishing bath, to a boil.

We get a good red on cotton-yarn by the following method, but it is not so permanent as the above : —

50 lbs. cotton-yarn.

First bath. To tub of water, at 120° F., add three lbs. tin crystals. Enter the yarn, and give seven turns. Lay the yarn down under the liquor for two hours. Then take out, and wash it off well.

Second bath. To a tub of cold water add three and a half ounces of magenta crystals (use one-half at a time; that is, add half of it to the tub). Then enter the yarn, and give it seven turns. Then take it out, and add the remainder of the magenta crystals. Re-enter the yarn, and give seven turns more. Take out and wash off.

Salmon Drab.

20 lbs. cotton-yarn.

Boil out four ounces sumac, and eight ounces annotto. Add the clear liquor to the dye-tub. Enter the yarn, and give seven turns. Raise it out, and add to the liquor one lb. alum. Re-enter the yarn, and give five turns. Take out and wash. The same shade can be obtained thus:

100 lbs. cotton-yarn.

Boil, until dissolved, two lbs. cutch. Add it to the dye-tub. Enter the yarn, and give five turns. Take out and wash off.

These are to be cold baths; but we have obtained a better and more permanent shade, by having the baths at a temperature of about 100° F. Either cold or warm, the shades are good.

Nankeen.

20 lbs. cotton-yarn.

First bath. Dissolve 8 ounces of copperas in a tub of cold water. Enter the yarn, and give ten turns. Take out; wring, and shake the yarn out well.

Second bath. Dissolve 8 ounces of lime. Let it settle. Use the clear liquor in cold water. Enter the yarn, and give five turns. Take out, wash off, wring and dry. This color will stand the bleaching process.

Linen Drab.

20 lbs. cotton-yarn.

Boil out five lbs. chip fustic. Cool down with cold water to 100° F. Enter the yarn, and give five turns. Raise up the

yarn, and add to the bath two ounces of copperas. Re-enter the yarn, and give five turns. Wash off, and wring out.

Orange.

$12\frac{1}{2}$ lbs. cotton-yarn.

First, or Lead and Litharge bath. Four lbs. brown acetate of lead; two lbs. litharge. Boil these until *all* dissolved. Add it to a tub of cold water.

Second, or Lime bath. Dissolve one pail of lime in a barrel of water. Let it settle. Take the clear solution, and add one-half of it to a tub of cold water. Now enter the yarn in the lime-bath, and turn it for fifteen minutes. Take it out, and enter it in the lead-bath. Turn for the same time. Take it out, and re-enter it into the lime-bath again. Turn it for the same length of time. Take out, and re-enter into the lead-bath again for the same time. Wring the yarn out well after coming from the lead-bath the second or last time.

Third, or Chrome bath. Dissolve in a tub of water, at 100° F., one and a half lbs. chrome. Enter the yarn in this, and give five turns. Take it out, and enter it into the lead-bath. Give it five turns. Re-enter it into the chrome-bath, and give five turns. Take out, and wring well.

Fourth, or Finishing bath. Take the remaining half-barrel of lime-water (which was not put into the second or lime-bath), and add it to a tub of clean water, and raise the temperature to 208° F. Now enter the yarn from the chrome-bath into this, and turn for fifteen minutes. Take out, and wash off.

Remarks on this Orange.

The lead and litharge are to be dissolved in ten quarts of water. Add five quarts of the solution to what is termed the lead-tub. Then add two and a half quarts when you enter the yarn for the second time in the lead-tub. The other two and a half quarts you must add to the lead-tub when you enter the yarn from the chrome-bath to the lead-bath, as described in manipulating the third or chrome bath.

You will notice that the yarn is passed twice through the chrome-bath. The first time it is passed through, you must use but three-fourths lb. of chrome. Then add three-fourths lb. more the second time it is passed through.

For a light orange, proceed as for orange, only do not pass it through the hot lime, or fourth bath.

Tan Brown.

50 lbs. cotton-yarn:

First bath. 7 lbs. Cutch,
14 ounces Blue Vitriol.

Boil until the cutch is dissolved, then cool down the solution to 160° Fahr., enter the yarn and give seven turns, then sink it under the liquor and leave it there overnight; next day take it out and wring it.

Second bath. Dissolve $1\frac{1}{4}$ lbs. chrome in water at 160° Fahr., enter the yarn and give seven turns; take out, wash off and dry.

Light Tan.

50 lbs. cotton-yarn:

First bath. $3\frac{1}{2}$ lbs. Cutch,
7 ounces Blue Vitriol.

Enter yarn and turn for three-quarters of an hour at 160° Fahr.

Second bath. 1 lb. Chrome.

Enter yarn and give seven turns at a temperature of 130° Fahr.; take out, wash off and dry.

Tan.

50 lbs. cotton-yarn:

First bath. Boil for half an hour,
$1\frac{1}{2}$ lbs. Sumac,
$\frac{1}{2}$ lb. Extract Logwood,
6 lbs. Cutch.

Enter the yarn and turn for twenty minutes at a boil.

Second bath. 1 lb. Blue Vitriol,
6 ounces Chrome.

Give five turns in this at 150° Fahr. Now add to the first bath six ounces chrome, enter the yarn and give three turns at 160° Fahr.; take out, and wash the yarn off and dry.

Another Tan.

50 lbs. cotton-yarn:

First bath. Boil up for half an hour,
$1\frac{1}{2}$ lbs. Sumac,
$\frac{1}{2}$ lb. Extract of Logwood,
6 lbs. Cutch.

Enter the yarn and turn for half an hour at a boil. Take out the yarn.

Second bath. 1 lb. Blue Vitriol,
$\frac{1}{2}$ lb. Chrome,
$\frac{1}{4}$ lb. Copperas.

Enter yarn at 150° Fahr., and turn for fifteen minutes. Take out the yarn. Now add to the first bath two ounces chrome; enter the yarn at 130° Fahr., and turn the yarn for ten minutes; take it out, wash off and dry.

Pink.

50 lbs. cotton-yarn.

Boil out twelve lbs. hypernic wood, add the clear solution to a tub of cold water, then add two lbs. tin crystals. Enter the yarn and turn for three-quarters of an hour; take out, and wash off in cold water.

Black.

50 lbs. cotton-yarn.

First bath. Boil until dissolved forty lbs. of cutch, cool down the solution to 190° Fahr. Enter the yarn and give ten turns.

Second bath. Add three lbs. nitrate of iron to a tub of cold water. Enter the yarn and give ten turns.

Third bath. Strip the yarn in lime-water; that is, pass the

yarn into a tub of cold water, in which has been poured the clear liquor from two lbs. of lime, and give five turns.

Fourth bath. Boil until dissolved twelve lbs. extract of logwood, cool down the solution to 160° Fahr. Enter the yarn and give nine turns in half an hour; take out the yarn and add to the liquor one-quarter lb. chrome, two lbs. copperas; re-enter the yarn and give seven turns.

Fifth bath. Wash off in soda-ash and oil, one pail to a tub of warm water.

To make the Oil Wash.

To one barrel of water add

25 lbs. Soda-ash,
10 gallons Palm Oil.

Boil until they are incorporated; then use one pail of this in a tub-box of warm water for every fifty lbs. of yarn.

Black.

100 lbs. cotton yarn:

First bath. Boil for half an hour, or until dissolved,

16 lbs. Extract Logwood,
2 lbs. Extract Fustic,
3 lbs. Soda-ash.

Cool down the solution to 160° F.

Enter the yarn, and give five turns. Lay it down under the liquor, and let it remain there until next morning. Take it up and wring out.

Second bath. Two lbs. blue vitriol. Turn the yarn for half an hour, at 160° F. Take out.

Third bath. One and one-half lbs. chrome. Enter the yarn and turn for half an hour at 160° F. Take out the yarn and wring it well. Now enter it again in the first bath, and give it seven turns. Take up and enter into the

Fourth bath. One lb. copperas. Enter the yarn at 160° F., and give seven turns. Take out and wash off.

Black.

50 lbs. cotton yarn:

Add to the box or tub,

12 lbs. Extract of Tamarack,

8 lbs. Copperas.

Enter the yarn at a boiling heat, and turn for fifty minutes at a boil. Take it out and wring out. To a box of cold water, add three-quarters lb. of chrome. Enter the yarn, and turn for half an hour. Take out and wring. Strip the yarn in a bath of lukewarm water, to which has been added three lbs. of whiting (carbonate of lime). After giving the yarn seven turns in this bath, take it out and wring it, and then finish off in a fresh bath of twenty lbs. logwood, and three lbs. of fustic. Boil these woods for one and one-half hours, then cool down the bath to 150° F. Enter the yarn, then turn for three-quarters of an hour. Then raise the yarn and add to the solution one-half lb. copperas; re-enter and turn for fifteen minutes; wash off the yarn, wring out and dry.

After the yarn has been taken out of the finishing bath, if it is washed in cold water, to which has been added a little chrome; it will improve the color, and will fix the logwood more permanently upon the yarn.

For the next fifty lbs. of yarn, add to the liquor of the first bath, eight lbs. of extract of tamarack, and six lbs. copperas; and for all subsequent lots use but five lbs. extract tamarack, and four lbs. copperas. By keeping the first liquor, you will thus save some expense. If you wish for a bluish black, put a little lime into the first or tamarack bath.

Aniline Black (a French recipe).

For every two lbs. of cotton-yarn, make up a bath with one-half lb. of blue vitriol; add one-half gill of muriatic acid. Give the yarn seven turns in this bath. Now make up a bath with two oz. of sulphide of copper, to every quart of water used in the bath. Enter the yarn in this, and give

it five turns. Take out the yarn and wash well. Next, dissolve in warm water, one lb. chlorate of aniline, and add it to a bath made up of

10 quarts	Water,
7 oz.	Chlorate of Potash,
6 oz.	Sal-Ammoniac.

Enter the yarn and give seven turns. Take it out and wring the yarn, then age it for forty-eight hours in a temperature of 77° F. Next, give the yarn five turns in a bath composed of fifteen grains of chrome to every pound of water used in the bath. Give the yarn five turns in this bath, then take it out, wash off, and dry it.

Fast Black.

25 lbs. cotton yarn:

First bath. Color the yarn a dark blue in the copperas-vat.

Second bath. In a tub of cold water, add one gill oil of vitriol; give the yarn five turns in this, then take it out, and wash off the yarn.

Third bath. Make up two tubs of cold water; to one add the clear liquor from six lbs. of lime, to the other add ten lbs. copperas; now enter the yarn into the lime-bath, and give it five turns; take out, and wring it out. Now give it five turns in the copperas-bath, then wring it out, re-enter it into the lime-bath, again giving it five turns, and wring out; re-enter in the copperas-bath again, giving five turns, and wring out.

Fourth bath. Boil out fifteen lbs. logwood, then cool down to 140°; enter the yarn and give seven turns, or turn until dark enough; take out, and wash off. If you wish, you can wash off the yarn in the oil-bath. (See recipe for it, page 172.)

REMARKS ON SILK-DYEING.

Silk is more generally dyed in the skein, than in the woven fabric. It is first boiled in soap to deprvie it of the gummy matter which forms the outer covering of the cocoon silk. It is then scoured, bleached, and sulphured. It is not sulphured unless it is to be colored with very bright colors and delicate light hues. It is dyed black by any of the following processes;

First. With logwood and'an iron mordant.

Second. With logwood and bichromate of potash.

Third. Nutgalls, and other substances that contain tannic acid, and nitrate of iron as a mordant.

Fourth. With aniline black, by the recipes of Persoz, Jr., and others, by the use of chromate of copper, and oxalate of aniline.

The first and second processes are known as the common or ordinary blacks, the third process being known as fast black. The first and second is done by simply giving the silk a mordant of nitrate of iron, then finishing it off with a solution of logwood. This cheap way of coloring it is generally applied to light silken fabrics, but the color will turn red when in contact with even weak acids, such as the juices of lemons, oranges, and other fruit juices. The fast blacks are more expensive, but are not affected by weak acids. The third process mentioned above has the advantage over the other processes, by increasing the weight of the silk (silk being bought and sold by weight). Silk absorbs from sixty to eighty times its own weight, and the silk used for shoelaces even two hundred per cent. of the dyeing materials.

In Germany there is an indigenous gall, named or locally known as *Knoppern*, which contains from thirty to fifty per cent. of tannic acid, which is used in the extract to color silk black. In England they use nutgalls, imported from the Levant, for coloring silk black.

Although the increase in weight of the silk by black dyeing

may be advantageous to the dealers, so much foreign matter in it is not only injurious to it in regard to the wearing qualities of it, but it also gives rise to the disagreeableness of its crocking or smutting while the material is being worn, and microscopic researches have proved that the color adheres very loosely to the silk.

The process for dyeing silk black is a very simple one. It is first steeped in a solution of nutgalls, the technical phrase of this part of the process being "galling." After this, the silk is next worked through a solution of nitrate of iron. Silk is colored black sometimes by first being colored a Prussian blue, then finished off as above; but more frequently a bluish tinge is given to it by first coloring it with logwood, copperas, and some blue vitriol. The weighting of silk is due to the fact that silk, being an animal product, it has the property of combining with tannic acid, and thereby will become heavier. The greater the amount of tannic acid there is in the coloring solution, or the oftener it is immersed in the nutgall solution, the heavier the fibre will become to a certain extent. It is not particularly essential whether copperas or nitrate of iron is used, but the nitrate is preferable. The silk, after being steeped in the solution of nutgalls, and then passed through the nitrate of iron solution, is at once colored black, but if it were passed through a solution of copperas, it would at first be colored only a black-violet, and would gradually become a black by exposure to the atmosphere, although in both cases the result is the same in the end. The use of the nitrate of iron is advantageous, and becomes more necessary where the galls contain a small amount of tannic acid, but for heavy weighting of the silk the copperas can only be used.

The coloring of silk black with aniline, chromate of copper, and oxalate of aniline, produces excellent results as far as we have learned.

Silk is colored blue either with indigo, prussiate of potash, or aniline. The indigo-vat has not been used much for color-

ing silk since the discovery of coloring it with the prussiate of potash. If indigo is used at all on silk, it is as carmine or purified sulphate of indigo (*sulphindigotic acid*). In coloring silk Prussian blue, it is first worked through a solution of nitrate of iron, then immersed in a solution of yellow prussiate of potash. In France, the iron mordant is made by dissolving copperas in nitric acid, and is known as *Raymond's solution*, and the blue produced by it and the prussiate, is called the *Raymond blue*. The Napoleon blue, so called, is made similar to the Raymond blue, the only difference being in using tin crystals in the iron mordant and sulphuric acid along with the prussiate of potash. This blue is more brilliant than the Raymond blue. In England, a tin salt is always used with the iron mordant, and after the silk has been worked a certain length of time in the mordant, it is then passed through a boiling soap-solution, then washed off, and next steeped in a solution of red prussiate of potash, acidulated with muriatic acid; from this solution it is passed, or washed off, in water containing ammonia, which adds greatly to its brilliancy.

Coloring silk with aniline, or naphthaline blue, is a very simple process. It only requires the passing of the silk through a solution of the dyes, the solvent of the dyes being alcohol or wood-spirit, or, in the case of the soluble blues, water, the silk being left in the aniline solution until it has assumed the desired shape.

Silk was always colored red and pink with cochineal, safflower, and archil, until the discovery of fuschine, by which, and with coralline, Magdala red, the reds on silk are colored, and the process for producing reds on silk with these substances is as simple as the process just described for aniline blue. The aniline red is the brightest, purest, and deepest of all red dyes for silk, yet it is not so fast as Magdala red.

Silk is dyed yellow, at the present time, mostly by picric acid, and some dyers adhere to the old method of first giving

it a mordant of alum, then finishing off with a solution of weld. The ordinary greens are produced on silk by first coloring yellow with either weld, fustic, or picric acid, and then finishing with indigo, carmine, or aniline blue; but the fast greens are produced by first coloring it blue with the prussiate of potash, and then finishing off with either quercitron or fustic. Greens are also colored on silk with iodine (aniline green). Red is printed upon silk by purpurine. In the first place, the silk pieces are mordanted with acetate of alumina (Al_2O_3, $2\,C_4H_3O_3 + 4\,HO$), with a little chalk added to the solution of alumina, then passing the silk through a weak solution of gum tragacanth. The printing-paste is made with one and a half ounces of purpurine, and half a pound of starch; heat the whole together, and print with it when cold. After the printing, the silk is steamed, then passed through soap, &c.

At the present time, most of the colors on silk are produced by the different aniline dyes. The methods or processes of fixing the aniline colors on silk are confined to the silk-dyer, and woolen-dyers do not try to inform themselves on the art of silk-dyeing, and we being unacquainted with that branch of dyeing, have only given a general outline of the methods employed, and leave the subject for those who are practically acquainted with the various processes for coloring this vegeto-animal substance to explain.

Water = H_2O.

The true composition of water was discovered in 1781 by Cavendish. The discovery made by him was, that upon burning certain and known amounts of hydrogen and oxygen in a dry vessel, he observed that water was formed or deposited on the sides of the glass vessel in which he tried the experiment, and that water was formed in quantity exactly equal to

the gases, in weight, which had disappeared. He also observed that these gases, would unite exactly in proportion of two volumes of hydrogen, with one of oxygen, and unite by weight, one to eight. Water, therefore, consists of one equivalent of hydrogen — 1, and one equivalent of oxygen, $8 = 9$, or of one volume of hydrogen and half a volume of oxygen condensed into one volume of steam. On these data, it is easy to calculate the specific gravity of steam, for its density will be 0.0689 (specific gravity of hydrogen) + 0.5512 (half the specific gravity of oxygen) = 0.6201, this being the specific gravity of steam.

Water, in a pure state, is a transparent liquid, without color, taste, or smell. Its specific gravity is assumed to be unity, and forms the term of comparison for that of solids and liquids. "A cubic inch of water, at the temperature of 60 F., weighs 252.5 grains."

Water is compressible, to a small extent, which was proved first by Canton, and afterwards, in an incontestable manner, by Perkins. "When the temperature of water is reduced to 32° F. (freezing point), it becomes a solid, or ice, and has the specific gravity of 0.9175" (Dufour). Water being possessed of such extensive solvent powers, cannot avoid being contaminated more or less with foreign matters, and will become variously impregnated according to the nature of the soil or strata through which it passes. When the foreign substances present are in so small an amount as not to materially alter its taste, and other sensible qualities, it constitutes the different varieties of *common water*. Prof. I. H. Appleton arranges the different kinds of water under the following heads :—

(a) Rain-water.
(b) Brook, or river water.
(c) Sea-water, or water of salt lakes.
(d) Well-water.
(e) Mineral spring-water.

The professor says the above are varieties of natural water. "And natural waters differ simply in the *character* and *amount* of the impurities they contain; these differences are due mainly to *the part of the natural circulation of the water at which we withdraw the sample* for examination."

"The evaporation taking place at the surface of the sea, and of all bodies of water, is the principal source of the moisture of the atmosphere; after this moisture has condensed as rain, the most of it returns to the sea by brooks and rivers."

"But some of the water, owing to peculiar surface configuration, or to greater or less permeability of surface strata, is either *arrested*, forming salt lakes, or *diverted*, as when it sinks below the surface and takes a subterranean course. In this latter case it often re-appears at the surface by natural fissures, as in the case of *mineral springs*, or by artificial ones, as in case of *wells*."

In regard to rain-water, he states that "the only impurities of carefully collected rain-water, are those it absorbs in passing through the atmosphere. They are oxygen, nitrogen, carbonic-anhydride, traces of ammonia gas, and (especially after thunder-storms) ammonic-nitrate. In the vicinity of large cities (especially where are many manufacturing establishments) rain-water also collects organic matters, dust of various kinds, and even sulphuric acid."

"Of course, rain-water collected upon *roofs* acquires impurities of greater quantity and of other kinds, from the materials of the roofs, and from dust which may have been collected there."

"So much as 1.2 grains of solid residue to the gallon of water (American wine-gallon), has been obtained from the evaporation of rain-water carefully collected in the city of Paris."

"Rivers derive their water from direct surface-drainage, and from springs whose water has taken a short subterranean course."

"The *character* of the impurities depends upon the character of the water-shed. Thus, water from a sandy soil, contains little impurity, not only because of the very slight solubility of the sand, but also because it possesses, to some extent, the remarkable power of removing both mineral and organic impurities from water filtered through it."

"The *amounts* of impurities likewise vary. The waters of rivers, draining thinly-settled territory, contain to the gallon about five grains of impurities, of which about two and a half grains are organic matter. Sometimes, indeed, river-water is scarcely less pure than rain-water. The amounts of impurities are, of course, much larger when the river receives the drainage of farms and human habitations and factories. Thus, the Thames, at London Bridge, contains 23.8 grains per American gallon."

There is a great difference in the impurities of water, as found in different localities and different sources, but all the varieties of water may be conveniently arranged under two heads; viz., *soft* and *hard*. A soft water is one which contains but few impurities, and which, when used with soap, very easily forms a lather.

By *hard water* is understood that kind of water which contains *calcareous* or *magnesian* salts, or other impurities, that cause the soap to *curdle* when washing with it. Tincture of soap is the easiest and most convenient test for ascertaining whether the water is *hard* or *soft*. In distilled water the tincture will produce no effect, in *soft* water it will change to a slight opal color, but in *hard* water, has a milky appearance. This milky appearance is due to the formation of an insoluble compound, between the oily acids of the soap and the lime or magnesia of the foreign salt.

The usual foreign substances contained in common water, besides oxygen and nitrogen, and matters held in a state of mechanical suspension, are carbonic acid, sulphate and carbonate of lime, and common salt. Carbonic acid is detected with lime, provided the lime-water is added before the water

to be tested has been boiled. The boiling of the water would drive off the acid, so that there would be no precipitate given by the addition of lime-water. The presence of lime in water is shown by there being a precipitate thrown down, when nitrate of baryta is added. After boiling the water add oxalate of ammonia, which will throw down precipitates if lime is present in the water. The nitrate of baryta test shows the presence of sulphuric acid, and after boiling the water, the ammonia indicates lime not held in solution by carbonic acid. Carbonate of lime, when held in solution by an excess of carbonic acid, may be detected by boiling the water, which causes the carbonate of lime to precipitate; but even after the boiling, there is still enough carbonate of lime left in the water to give a precipitate with acetate of lead, carbonate of lime being itself, to a minute extent, soluble in water. Distilled water, and pure, are useful for all purposes of the arts; yet a water may be soft and useful for bleaching and washing, and still deleterious in dyeing; and it may be *hard*, and still be good water for dyeing most colors. The terms *hard* and *soft* do not denote impurities of any particular kind. The impurities in water are often so minute that ordinary tests do not, for some time, detect them. The best method of proceeding will be to apply the tincture of soap test (dissolve white soap in alcohol, this is tincture of soap), as a sort of guide. Next, to try the water with delicate test-paper; then to observe if it has an alkaline or acid re-action. Now, take a gallon of the water to be tested and boil it down to one pint; pour this into a narrow jar and let it remain until it has settled, pour off the clear liquid into another vessel, and preserve the turbid part for examination. This turbid precipitate will, no doubt, be carbonate and sulphate of lime, with a trace of iron. If these substances are in the precipitate, by adding to it some muriatic acid, the carbonate of lime and iron will dissolve with effervescence, while the sulphate of lime will remain undissolved. A few drops of tannic or gallic acid added to a portion of the pint of

water will turn it a bluish color, if iron is present in it. Divide the water which was boiled down to a pint into five portions, and put them into five small glasses; to one, add gallic acid; it will give a bluish color if iron is present. To the second portion add a few drops of oxalate of ammonia; if lime is present there will be a white precipitate thrown down. To the third portion add some phosphate of soda, and stir it up well; if the water contains magnesia there will be a white precipitate left. To the fourth portion add chloride of barium, and if a white precipitate is obtained that does not re-dissolve by adding a little nitric acid to it, then the water contains sulphuric acid. To the fifth portion add nitrate of silver; if a white precipitate is formed and does not re-dissolve by the addition of nitric acid, then the water contains muriatic acid. These tests and the nitric acid must be perfectly pure, or no dependence can be placed upon the results.

Parkes gives the following tests for water in his chemical essays: —

TESTS USED AND	WHAT THEY WILL DETECT.
The oxalates, or oxalic acid, .	Lime.
Litmus, ...	Uncombined acids.
Tumeric paper, . . .	Alkalies and alkaline earths.
Chloride of platinum in alcohol,	Potash.
Polished iron or steel, . .	Copper (with precipitates).
Phosphate of soda, . .	Magnesia.
Lime-water, ...	Cabonic acid.
Chloride of lime, . . .	Carbonated alkalies.
Salts of barytes, . . .	Sulphuric acid or sulphates.

The above substances are sometimes so minute that the common tests do not always detect them.

"The solvent powers of water are of a very wide range; there are but few solid, liquid, or gaseous substances which

are not dissolved to some extent by it. In case of rain-water, the solvent powers are somewhat further increased by carbonic-anhydride, which it acquires from the atmosphere, and which, after falling, it acquires in still greater quantity from the decaying organic matters with which it comes in contact in filtering through the suface strata. Many carbonates, as calcic carbonate, which are only very slightly soluble in pure water, are much more so in water containing carbonic-anhydride, with which they are supposed to form bicarbonates.

"Well-water almost invariably contains the following substances:—

"$Ca\ SO_4$, ...	Gypsum.
$Ca\ CO_3$, ...	Chalk.
$Mg\ CO_3$, ...	Magnesia.
$Na\ Cl$, ...	Common Salt.
$K\ Cl$.	
$Si\ O_2$, ...	Sand.
$Fe\ CO_3$.	
$Al_2\ (CO_3)_3$.	

Organic Matter.

Occasionally it contains

$Ca\ (NO_3)_2$, . . .	Calcic Nitrate.
$(NH_4)_2\ CO_3$ . . .	Ammonic Carbonate.

"A well-water containing, per gallon, twenty grains of mineral matters of the character of those first enumerated, and from three to five grains of vegetable matters, and which is *free from ammonium compounds* is considered suitable for drinking purposes. Drinking waters containing larger quantities of mineral matters are thought to produce the gravel and similar diseases.

"When wells are situated in thickly peopled districts their

waters often become impregnated with animal matters, which have come from cesspools, &c. These animal matters, by their partial decomposition, give rise to ammonia, nitrates, and nitrites which thus serve as indicators to the nitrogeneous matters in which they originated. If such waters are used for drinking waters, they become highly injurious to health."

"For domestic purposes, as *washing* and *cooking*, it is very desirable to use a water containing less mineral matter than the amounts above specified. Much calcic and magnesic salts impart to the water the peculiarity termed *hardness*."

"By use of hard water with soap, the calcium and magnesium combine with the fatty acid-radical of the soap, and thus form insoluble, hard, granular, and inactive calcium and magnesium soaps, which do not froth, and do not possess the detergent properties of sodium and potassium soaps." — *Appleton's Quantitative Analysis.*

Water is used in the dye-house as a solvent, yet its solvent property depends greatly upon certain laws, the action being the mutual attraction between the fluid and solid, and will become weaker as these attractions are satisfied. For example: we will take a piece of alum, and suspend one part of it in water; the water will be immediately drawn or sucked up into the pores of the alum, and will adhere to the particles of the alum; but if more water than what is sufficient to wet the particles is allowed to enter the solid parts of the alum, the alum will break, dissolve, and disappear in the water. Yet the action of the water upon the salt is limited, it being very powerful at first; but the alum becoming diffused through the water, the action of the water upon the solid parts of the alum will gradually decrease as the water becomes more and more saturated with the alum, until it will dissolve no more. We then say that the water has become entirely saturated with the salt.

When any of the crystallized salts are put into a pail or other vessel, and water poured upon it, and allowed to stand for a length of time, we find that it is a long time in dissolv-

ing, because the water which surrounds the crystallized salt becomes saturated, and is therefore incapable of dissolving any more of the salt, as the salt, from its weight, remains at the bottom of the pail or vessel. To illustrate this, we will take three glasses, each being filled with water; we now add to each an equal quantity of blue vitriol. In one we will let the crystals remain at the bottom of the glass; the second one we will stir constantly; we will suspend the blue vitriol upon the surface of the water in the third glass. We now can observe the action of the water in each case, and observe the difference in time which it requires to entirely dissolve all the blue vitriol, the result being, that which was suspended upon the water's surface is the soonest dissolved.

Hot water, every dyer knows, will dissolve more of a crystallized salt than cold water will. The relation of the different dissolving powers of water, at different degrees of temperature, is very remarkable. Some of the salts will dissolve as well at one degree of temperature as at another, and equally as readily: common salt, for instance. Some dissolve the least in cold water, and will increase gradually as the water becomes heated. Some salts increase in their solubility rapidly, until the temperature of the water arrives at a certain heat, after which the salt will become less soluble, while such substances as lime will dissolve more readily in cold than in hot water. One pound of lime will dissolve in sixty-six gallons of water, at 32° F., but it requires seventy-five gallons, at 60° F., to dissolve the same amount. Boiling water will not contain but one-half of the lime that water at 32° can. This fact is well known to cotton-yarn dyers, as they often experience these effects in the *raising* of chrome-oranges.

Water, besides having the property of dissolving solid bodies, has also the same property for dissolving gases and holding them in solution. In the latter case, cold water is a more powerful solvent for the gases than hot water is. There are gases, if held in solution by water which is used in col-

oring, that would be very injurious (especially in cotton dyeing), and as many of these gases are floating about in the dye-house, they may be, in small quantities, absorbed by the water contained in the dye-tubs, and the cause of the imperfect color which is obtained may not be known or thought of.

The following are a few of the gases present in the dye-house:—

Nitrous oxide. Chlorine. Carbonic acid.
Sulphurous acid. Sulphuretted hydrogen.

Any one of these gases, in water, will affect colors, and they are all, to a more or less extent, gases which are given off in a dye-house.

It has been stated by some chemists, that water was entirely neutral, and as having no action upon matters put into it. This will appear doubtful to the practical dyer, as his experience has taught him that the water in different localities has a different effect upon the same dyestuff. He also finds that certain kinds of water are better for his colors than other kinds, which manifests a difference either in the constitution or condition of the water. This difference in water depends upon foreign matters which are dissolved in it. Therefore, it would be a great object for the dyer to always have pure water. But this is almost impossible for him to have, although there a number of rivers in the New England States that are as pure as it is possible to have (unless we employ distilled water), and there are not any foreign matters in them, that would injure the most delicate color we would wish to place upon any fabric. As we stated above, it would be an object for the dyer to have pure water. It would also be a great object to him to know what are the matters or ingredients which are in the water he was using, so that he could either counteract their effects, and obviate their consequences, or else render them subservient to his purposes. The great and

most practical importance of water to the dyer, is not only its solvent powers, but also its neutrality. The best water we have used for coloring black, and other *sadden colors*, were the western waters, and especially that at Lawrenceburgh, Ind., which, by analysis, was found to contain sulphuric, muriatic, and carbonic acids, large quantities of lime, and a trace of iron, the solid contents of which were 135 grains per American gallon. No doubt, these ingredients existed in the water as carbonate, muriate, and sulphate of lime, and the carbonate of iron. In coloring with the above-named water, we found that it required a much less quantity of logwood to produce a jet black than it did in the Eastern States. This is accounted for thus: lime aids or assists the water in dissolving the coloring-matter contained in the logwood, and, as dyers say, *springs* the wood more. Lime, as well as soda-ash in water, greatly assists the water in extracting the color from camwood, as well as from logwood.

ACIDS.

Acids are compounds which are capable of uniting, in definite proportions, with alkalies, earths, and ordinary metallic oxides, with the effect of producing a compound in which the properties of its constituents are mutually destroyed. Most acids have a sour taste, and possess the power of changing vegetable blues to red; and, though these properties are by no means constant, yet they afford a convenient means of detecting acids applicable to most cases.

The above explanation of the nature of an acid is that which is usually given; but, according to strict definition, acids are compounds having a strong electro-negative energy, and, therefore, possessing a powerful affinity for electro-positive compounds, such as alkalies, earths, and ordinary oxides. It is this antagonism in the electrical conditions of these two great classes of

chemical compounds that gives rise to their mutual affinity, which is so much the stronger as the contrast in this respect is greater. In the majority of cases, the elective-negative compound, or acid, is an oxidized body, but by no means necessarily so. When an acid does not contain oxygen, hydrogen is usually present. These peculiarities in composition have given rise to the division of acids, by some writers, into *oxacids* and *hydracids*. *Vegetable acids*, for the most part, contain both hydrogen and oxygen. Strictly speaking, there are but three kinds of acids; viz., sulphuric, muriatic, and nitric acids. There are a large number of substances termed acids, such as oxalic, acetic, tartaric, citric, benzoic, gallic, tannic acid, &c., &c.

"Acids are the antagonistic principles to alkalies. They neutralize alkalinity, and form salts by their union with alkalies. They combine with earths also, and, in general, these compounds are soluble; but there some that are not soluble. They act upon metals, oxidizing, combining with, and dissolving them, thus bringing the base of colors into a tangible form, so that the coloring principle will operate upon them. They will modify the shade of color, changing the purples to red or orange, and the reds to orange or yellow, making the yellows brighter, lighter, and more lemon-colored in their shade.

"Thus we see the primary importance of these substances in the art of dyeing, and the necessity of their presence in colors."

Acids enter into the composition of all the crystallizable salts, or chemical compounds, or mordants which have been noticed in this work, and are the medium or cause of solubility of almost all of their radicals. Acids, in an uncombined or free state, attack vegetable fibre, and injure its strength, even when somewhat diluted with water. Alkalies operate upon animal matter in the same respects as acids do upon vegetable matter. Acids are not very injurious to wool, unless used to excess, and of considerable strength, or aided by heat. Woolen fabrics will bear a greater amount of acids,

without injury, than they can bear the use of an alkali. The acids seem to combine somewhat with the wool, causing the goods to *full* and *scour* with more difficulty. When either of the three proper acids are combined with other elements, they are called salts. Thus, sulphuric acid and iron, for sulphate of iron (salt of iron).

We have below condensed, from Napier's Chemistry, the nature and nomenclature of salts.

"The acids combine with metals, and form compounds, which are termed *salts*. The names of these also denote their composition: the salt formed between the acid terminating in *ic* and a base, ends with *ate;* that formed by the acid terminating in *ous*, ends with *ite*, the name of the element with which the acid combines, being added. Thus, sulphuric acid (SO_3) and iron (Fe) form *sulphate of iron;* sulphurous (SO_2) and iron (Fe) form *sulphite of iron.*

"When these acids unite elements or bases in different proportions, the same prefixes are used as with oxides. If one proportion of acid unites with one of another element, the compound is termed *proto*,— as protosulphate of iron; if two of acid and one of metal, the compound has *bi*,— as bisulphate of iron, &c. *Per* is also used, as denoting the highest proportions, as when three equivalents of acid, unite with two equivalents of iron, the salt is termed *persulphate of iron.*

"Sometimes we have the metal uniting with acids, forming basic salts." For instance, if one proportion of oxygen combines with three of metal, the prefix *trisub*, or *tridi*, is occasionally used; but this is not at all times convenient. The best plan is to denote such compounds as *basic*, and then apply the ordinary prefixes, such as bibasic, tribasic, &c., as

Cu_2O, bibasic oxide of copper.
Cu_3O, tribasic oxide of copper.

Where we have two proportions of metal to one of acid, or the equivalents or proportions of metal to one of acid, the

same prefixes are used as above stated; the two proportions of metal to one of acid, is termed *bibasic*-sulphate of copper, and the other named preparations are termed *tribasic*-sulphate of copper. Where water is combined with salts or oxides, they are termed *hydrates*, or *hydraus*, to distinguish them from substances that contain no water, which are called *anhydraus*; thus, hydrate of potash, or hydrous potash, KO HO; anhydrous potash, KO.

Double salts are two salts united together to form a definite compound, such as alum, that being a double salt of sulphate of alumina, and sulphate of potash.

"In the name of a compound ending in *ide*, the base or element in which oxygen is combined, is named last, as

Oxide of iron	(Fe O),	composed	of oxygen and iron.
Chloride of iron	(Fe Cl),	"	of chlorine and iron.
Iodide of iron	(Fe I),	"	of iodine and iron.
Oxide of sulphur	(OS),	"	of oxygen and sulphur.
Oxide of nitrogen	(ON),	"	of oxygen and nitrogen."

"But in those compounds that contain acid properties, the base is placed at the beginning, thus:

Sulphuric acid, ...	sulphur and oxygen.
Nitric acid, ...	nitrogen and oxygen.
Hydrochloric acid (muriatic acid),	hydrogen and chlorine."

Rules for Naming Compounds.

"When two elements combine together, and the compound formed has not acid properties, the name ends in *ide*, such as *oxide*, *chloride*, *bromide*, *rodide*, &c.

"Sometimes *uret* is used instead of *ide*, such as in *sulphuret*, *carburet*, *phosphuret*, &c. But *ide* is now generally adopted even for these, giving *sulphides*, *carbonides*, and *phosphides*."

"When the compound formed by the union of the elements has acid properties, the name ends in *ic*, or *ous;* thus we have

sulphuric, sulphurous, nitric, nitrous, chloric, chlorous acids. Thus, these elements, uniting together in different multiples, have prefixes added to express the number of proportions. Thus, *proto* denotes one proportion; *dento*, or *bi*, two proportions; *trito*, three proportions; *per* denotes no particular number, only the highest proportion.

"For examples, take the compounds nitrogen and oxygen:

NO, protoxide of nitrogen.
NO_2, binoxide of nitrogen.
NO_3, nitrous acid.
NO_4, peroxide of nitrogen.
NO_5, nitric acid.

"Thus we see, the full name of the substance not having acid properties, denotes its composition. In the case of acids, it does not tell the number of elements combined, as with oxides, *ous*, simply signifying that it has less oxygen than another acid composed of the same elements, and which ends in *ic*." [*For instance, nitrous acid contains but two proportions of oxygen* (NO_2), *while nitric acid* (NO_5) *contains five proportions of oxygen.*]

"There are sometimes more than two acids formed by the combining of the same elements. In this case, if the oxygen is less than in the acid whose name terminates with *ous*, the prefix *hypo* is put to the name of the *ous* acid. If there be more oxygen than in the *ous* acid, and less than the *ic* acid, the same prefix is made to the last-named acid.

"Finally, when there is more oxygen present than in the acid whose name terminates with *ic*, the prefix *per* is used as in oxides. Thus, for examples, to illustrate these terms:

S_2O_2, hypo-sulphurous acid.
SO_2, sulphurous acid.
S_2O_5, hypo-sulphuric acid.
SO_3, sulphuric acid."

"Any acid having more oxygen, in relation to the sulphur, than the last-named in the above list, would be called *per*-sulphuric acid. It will thus be seen, that the names of the compounds denote their composition, and gives an idea of their leading properties."

"The term *sesqui*, — as *sesquioxide*, — is often used, and means one and a half of an equivalent, which, as may be inferred from what has been said, cannot take place. Nevertheless, the name is conveniently retained to denote such compounds as have two of one element, and three of another, such as sesquioxide of iron (Fe_2O_3), also termed peroxide, which is composed of two of iron (Fe_2), and three of oxygen ($O_3 = Fe_2O_3$).

"Sometimes one proportion of oxygen, chlorine, &c., combines with two proportions of a base as a metal; such compounds have the prefix *sub* or *di* thus,—

> Fe_2O, sub-oxide of iron, or dinoxide of iron.
> Cu_2Cl, sub-chloride, or dichloride of copper."

As regards the constitution of salts, it is not our intention to define the merits of the different views taken by chemists in regard to the constitution of chemical salts, but merely and briefly to give a general idea to the student in dyeing. For an example we will take sulphuric acid. The composition of this acid is given by *Berzelius* thus, SO_3. Now we find that SO_3 is a solid crystalline compound, which has no acid properties until it is combined with one proportion of water, and its formula would be $SO_3 + HO$ (hydrous sulphuric acid).

Sir H. Davy thought that as sulphuric acid, SO_3, had no acid properties, and was not capable of combining with any body as such, unless in union with water, it was the more probable that what is termed hydrated sulphuric acid ($SO_3 + HO$), might be the correct composition of sulphuric acid, rather than the formula SO_3, and should be represented thus, $SO_4 + H$, the hydrogen being the base or metal, and that the

presence of hydrogen is an essential qualification to the acid, so that a piece of iron being put into sulphuric acid the reaction would be expressed thus, $SO_4H + Fe = SO_4Fe + H$, or thus,—

$$\left.\begin{array}{r}\text{Sulphuric acid}\left\{\begin{array}{l}\text{H — hydrogen gas.}\\ SO_4\end{array}\right.\\ \text{Iron} = Fe\end{array}\right\}\text{ sulphate of iron.}$$

A greater number of our modern chemists express sulphuric acid thus, H_2SO_4.

Names have been proposed in accordance with Sir H. Davy's views; as, for instance, the SO_4 is to be termed *sulphion;* therefore the formula $SO_4 + H$ being termed sulphuric acid, will be sulphionide of hydrogen, instead of sulphuric acid. It will, however, be a difficult task to introduce such names into science; even if they were approved of, their use will have to be a slow but gradual growth.

The views that are given above of the true formula of sulphuric acid, can be applied to all hydrated acids. The formula of nitric acid, NO_5, for instance, has never to our knowledge been isolated, but its existence is merely supposed from analogy. For hydrated nitric acid we have the formula, $NO_5 + HO$; but why this formula, rather than this, $NO_6 + H$, or this, HNO_5? Any metals dissolving in nitric acid replace the hydrogen only. The same may be said of muriatic acid, HCl (more properly termed hydrochloric acid), which we know to be a compound of hydrogen and chlorine. If we dissolve a metal in muriatic acid, we find that the acid, and not the water is decomposed. Or turn muriatic acid upon soda, we find that the action is not that of the acid combining with the oxide, but that there is a double decomposition, which, according to Davy, is represented thus: $HCl\ HO + NaCl + {}_2HO$. Proving that these bodies which are termed muriates should be more properly named chlorides.

We have only stated the fundamental principles of these views as a general guide to the young dyer in his inquiries into

chemical science, and if he wishes to obtain more extended information, he should study such works as Dumas's Lectures upon Dyeing, Thomson, Graham, Wagner and others, who have given this subject a great deal of attention and investigation. It will ample repay any time and labor he may expend upon it, as upon the proper understanding of the primary and fundamental laws of affinity, in a great measure depends the right application of chemical science to practical purposes, and most especially in the various operations of dyeing.

SULPHURIC ACID = H_2SO_4.

The sulphuric acid, or oil of vitriol of commerce, is composed of 81.5 parts of anhydrous sulphuric acid and 18.5 parts of water. There are in the market two distinct kinds of this acid,—the fuming or Nordhausen sulphuric acid, and the ordinary or common oil of vitriol. The Nordhausen derives its name from the place where it is manufactured in Germany. The method of preparing this kind of acid is very old, and is still practised in Nordhausen. It is a very strong acid, and has a dark color, and gives off a large amount of white fumes, for which reason it is called fuming *oil of vitriol.* This is the best acid of the two kinds for making sulphate of indigo, or chemic.

At a red heat, all sulphates, except those of the alkaline earths, are decomposed, for which reason they can be employed for manufacturing fuming sulphuric acid, but the sulphate of iron ($2Fe\ SO_4$) being cheaper than the other sulphates, it is mostly used in preparing fuming oil of vitriol. By exposing this salt to a red heat, it will be decomposed into anhydrous sulphuric acid and sulphurous acid (SO_2). Anhydrous sulphuric acid ($HO\ SO_3$) could be obtained from sulphate of iron, if the sulphate could be possibly procured perfectly anhydrous, but as this is not possible to do without decomposition, some water is always retained, the result being the compound known as fuming sulphuric acid; that is, a mixture of anhydrous and common oil of vitriol ($HO\ SO_3$).

The method of preparing fuming sulphuric acid is as follows: "The solution of sulphate of iron (2Fe SO_4) is first evaporated to dryness, and then dried in open vessels as much as possible. The dry saline mass (vitriol stone it is called in Germany) is next transferred to fire-clay flasks, placed in a galley furnace, the necks of the flasks passing through the wall of the furnace, and are properly fastened to the necks of the receivers. Into each of these flasks two and a half pounds of the vitriol stone are put; at the first application only sulphurous acid and weak hydrated sulphuric acid comes over, and is usually allowed to escape, the receivers not being securely luted until white vapours of anhydrous sulphuric acid are seen." "Into each of the receiving flasks thirty grammes of water are poured, and the distillation continued for twenty-four or thirty-six hours. The retort-flasks are then filled again with raw material, and the operation repeated four times before the oil of vitriol is deemed sufficiently strong. The residue in the retorts is red oxide (peroxide of iron, $Fe_2\ O_3$) of iron, still retaining some sulphuric acid. The quantity of fuming acid obtained amounts to forty-five or fifty per cent. of the weight of the dehydrated sulphate of iron employed. At Davidsthal, in Bohemia, fourteen hundred weight of this vitriol stone will yield in thirty-six hours five and a half hundred weight of fuming sulphuric acid."

It is preferable to use sulphate of the peroxide of iron instead of the protosulphate; the sulphate of the peroxide can be easily made by using the peroxide and the ordinary or common oil of vitriol. Frequently the fuming acid is made by passing anhydrous sulphuric acid obtained by calcining perfectly dehydrated protosulphate of iron, or, still better, the persulphate of iron, into common oil of vitriol. It is also now and then made from the bisulphate of soda left after making nitric acid from saltpetre.

The concentrated oil of vitriol is prepared, on a large scale, in leaden chambers, and dates as far back as 1746. "Dr.

Roebuck of Birmingham, Eng., erected the first leaden chamber in Edinburgh. Although the use of leaden chambers is due to an Englishman, the present mode of manufacturing sulphuric acid was invented by a calico-printer at Rouen, in 1774, and improved by the celebrated Chaptal." Many methods have been suggested for manufacturing sulphuric acid, but none have anywhere superseded the process generally adopted. We will mention a few only of the re-actions upon which these methods are based. Persoz's method is based upon the following re-actions: "First. Oxidation of sulphurous acid by means of nitric acid, the latter being heated to 100° Fahr., and diluted with four to six times its bulk of water. Second. The vapors of hyponitric acid are again converted to nitric acid by the oxygen of the air and steam. In this process, the leaden chambers are replaced by a series of large earthenware bottles, called a Woulfe's apparatus." "Hahner's method is based on the oxidizing of sulphurous acid with chlorine, care being taken that steam is present at the time, and is thus expressed:—

$$\left.\begin{array}{ll}\text{Sulphurous acid,} & SO_2,\\ \text{Aqueous vapor,} & 2H_2O,\\ \text{Chlorine,} & {}_2Cl,\end{array}\right\}\ \text{yield}\ \left\{\begin{array}{l}\text{Sulphuric acid, } HOSO_3.\\ \text{Hydrochloric acid, } HCl."\end{array}\right.$$

Although enormous quantities of gypsum are found native, all attempts to prepare sulphuric acid from this mineral have failed, in an industrial point of view. The composition of gypsum, or sulphate of lime, is as follows, in one hundred parts:—

Sulphuric acid,	SO_3, (anhydrous,)	43
Lime,	Ca,	33
Water,	HO,	24 = 100

Sulphuric acid is one of the most important compounds of sulphur. This acid is a corrosive substance, converting animal and vegetable matter into charcoal, the hydrogen and nitrogen of these substances forming water, which combines

with the acid and leaves the carbon as charcoal. It is the only liquid that will combine with and dissolve indigo without deoxidizing it, but to effect this it must be concentrated.

Sulphuric acid has great attraction for moisture. It will combine intimately with water in any proportion, yet there seems to be certain definite qualities that will combine with it chemically. When water is added heat is evolved (this heat is a definite quantity), and is accompanied by great condensation of bulk, as the dyer can convince himself by taking equal quantities of strong oil of vitriol and water and mixing them, when, after the mixture becomes cold, he will find a much less quantity. The heat of this mixture, when first put together, will reach the boiling-point, or 212°.

This acid will combine with alkalies, earths, and metals, and the salts thus found are called sulphates of the particular base to which it is united,—such as alum, copper, iron, and lime. They are then called sulphate of alumina, sulphate of copper, sulphate of iron, sulphate of lime, &c. Carboys containing oil of vitriol, muriatic, and nitric acids should be kept well corked, or stopped up, as they all absorb moisture very readily when exposed to the atmosphere.

We will here insert a few of Fesquet's experiments upon the amount of condensation and heat given out, which were performed with a common thermometer and alkalimeter. These experiments were on sulphuric acid:—

Measures of water.	Measures of acid.	Heat when mixed.	Increase of heat.	Loss by condensation.
90	10	86°	40°	5
80	20	116	70	7
70	30	154	108	8
60	30	188	142	9½
50	50	210	164	11
40	50	212	166	11
30	70	164	154	9
20	80	136	118	8½
10	90	-	90	7

"The above was the mean of three trials; the proportions of acid and water were taken to make 100 graduations. The heat was observed immediately after mixing, and the mixture was kept in a stopped bottle until cold, when it was measured by the alkalimeter, and the loss by condensation noted.

"The heat of the water and acid separately was 46° Fahr. The acid used had a specific gravity of 1.795, taken by Twaddle.

"Another proof that water and sulphuric acid form a definite compound is, that when the acid has the specific gravity of 1.78, the composition is $SO_4H + HO$. This, at a temperature of 32° will crystallize in large and regular crystals, while stronger or weaker acid, at the same temperature, will not crystallize."

Dyers often complain of their acids being weak, and charge the manufacturer of them with making poor acids, when in fact it is their own fault; by their carelessness in leaving the carboys unstopped, they allow the acid to absorb moisture from the atmosphere, causing it become diluted. Let any one place a cup half full of oil of vitriol exposed to the atmosphere, and he will be astonished at the short time it takes for the cup to become full.

"The impurities of sulphuric acid are lead, nitric acid, arsenic, and sulphate of potash; the potash is used to give the acid density. Sulphate of potash or soda can be detected in oil of vitriol by putting a few drops of the acid into a small earthen basin and saturating it with ammonia; then evaporate it to dryness and apply a strong heat to it until all the white fumes of sulphate of ammonia cease rising, and if the acid is pure there will be nothing left.

"Lead can be detected in the acid by adding a little distilled water to it, and if lead is present it is converted into a sulphate of lead, and is not soluble in diluted acid; so by adding water to sulphuric acid that contains lead there will be produced a milkiness in the solution, which shows the presence of lead. If nitric acid is present it can be detected

by taking a good bright crystal of copperas and suspend it in the acid and apply heat. A black ring will form around the crystal of copperas, or you will perceive the smell of peroxide of nitrogen, if nitric acid is present in the oil of vitriol."

The most highly concentrated sulphuric acid contains 18.46 per cent. of water; its formula, $HOSO_3$; specific gravity, 1.848. In a perfectly pure state it is a colorless liquid, but it is generally more or less yellow or brown colored, owing to the presence of organic matter. The boiling point of highly concentrated oil of vitriol is 338° Fahr.

The uses of sulphuric acid are so numerous that it would be impossible to name all of them, sulphuric acid being to chemical industry what iron is to the mechanical. Sulphuric acid is employed in preparing a great many other acids, such as nitric, muriatic, sulphurous, carbonic, phosphoric, tartaric, and citric acid. It is also used in making soda, superphosphates, sulphate of ammonia, alum, sulphates of copper and iron; in refining paraffine, petroleum, and silver; for the manufacturing of garancine, garanceux, and other madder preparations. It is used by the dyer in making sulphate of indigo (chemic) with muriatic acid as a solvent for tin in making the solution of murio-sulphate of tin.

"The following table gives the quantity of anhydrous sulphuric acid contained in sulphuric acid at 15.5 C.: —

Hydrated Sulphuric Acid	Specific gravity.	Anhydrous Acid.	Hydrated Sulphuric Acid.	Specific gravity.	Anhydrous Acid.
100	1.8485	81.54	93	1.8290	75.83
99	1.8475	80.72	92	1.8233	75.02
98	1.8460	79.90	91	1.8179	74.20
97	1.8439	79.09	90	1.8115	73.39
96	1.8410	78.28	89	1.8043	72.57
95	1.8376	77.40	88	1.7962	71.75
94	1.8336	76.65	87	1.7870	70.94

Hydrated Sulphuric Acid.	Specific gravity.	Anhydrous Acid.	Hydrated Sulphuric Acid.	Specific gravity.	Anhydrous Acid.
86	1.7774	70.12	69	1.5868	57.26
85	1.7673	69.31	68	1.5760	55.45
84	1.7570	68.49	67	1.5648	54.63
83	1.7465	67.68	66	1.5503	53.82
82	1.7360	66.86	65	1.5390	53.00
81	1.7245	66.05	64	1.5280	52.18
80	1.7120	65.23	63	1.5170	51.37
79	1.6993	64.42	62	1.5066	50.55
78	1.6870	63.60	61	1.4960	49.74
77	1.6750	62.78	60	1.4860	48.92
76	1.6630	61.97	59	1.4760	48.11
75	1.6520	61.15	58	1.4660	47.29
74	1.6415	60.34	57	1.4560	46.58
73	1.6321	59.55	56	1.4460	45.68
72	1.6204	58.71	55	1.4360	44.85
71	1.6090	57.89	54	1.4265	45.03
70	1.5975	57.08	53	1.4170	43.22

The composition of hydrated sulphuric acid of the specific gravity of 1.845 (1.8485, Ure) consists of 1 equivalent of dry acid, 40, and 1 equivalent of water, 9 = 49. As the water acts the part of a base, the proper name of it would be sulphate of water, its formula being $HOSO_3$. The dry acid consists of 1 equivalent of sulphur, 16, and 3 equivalents of oxygen, 24 = 40, as above stated. The ordinary commercial acid (specific gravity, 1.8433) consists, according to Phillips, of 1 equivalent of dry acid, and $1\frac{1}{4}$ equivalents of water. The hydrated Nordhausen acid has a density as high 1.89, and consists of 2 equivalents of dry acid, and 1 equivalent of water ($HO, 2\ SO_3$).

Sulphuric acid, commonly called *oil of vitriol*, is a dense, colorless, inodorous liquid, and strongly corrosive, and upon living tissues it acts as a powerful caustic. It contains water, which is essential to its existence. It unites with water in all proportions, and great heat is evolved on mixture of the two fluids. If its density exceeds 1.8485 it contains lead or other impurities; at the above density it contains 18 per cent. of

water; at a density of 1.8433 it contains 22 per cent. of water; it boils at 620°, and freezes at 15° below zero. The usual impurities in this acid are the sulphates of potash and lead. The former impurity is derived from the residue of the process; the latter, from the leaden boilers in which it is concentrated. Occasionally nitre is added, to give it density, and to render dark-colored acid colorless. These impurities often amount to three or four per cent. The commercial acid cannot be expected to be absolutely pure, but when it is properly manufactured it should not contain more than one-fourth of one per cent. of impurity. If sulphate of lead is present, the acid will become turbid, if it is diluted with an equal weight of water.

Hydrochloric Acid = HCl, or Muriatic Acid.

This acid has been known from an early period in history by the name of marine acid, spirits of salt, &c. It is a gaseous substance, and very soluble in water, in which condition it is employed. This gas is produced by the decomposition of common salt and sulphuric acid, and in order to effect its condensation, the gas is conveyed to coke columns; but in most instances the gas is prepared and condensed by the aid of several cast-iron furnaces, fitted up similar to gas-retorts, with lids luted with clay. One of these lids is provided with an opening, so as to fit in the stone-ware or lead pipe that leads to the condensing jars; the gas passes through this pipe into the jars; these jars contain water for the absorption of the gas, and are called a Woulfe's apparatus. There is another lid to these retorts, at the end, with an opening in it; in this opening is a lead funnel attached, so that after the retort is filled with the proper amount of salt, sulphuric acid may then be poured in.

There are generally two retorts, and they are so constructed that the fire can play around them before reaching the flue or chimney. The first operation is to fill these retorts with the quantity of salt required. The lids or covers are then luted

on and the fire kindled. The required amount of strong sulphuric acid is now poured into the retort through the funnel, then the funnel is taken out and the hole is closed with clay. As soon as the re-action is over the sulphate of soda produced by the acid and salt is taken from the retorts and the operation is again repeated. The condensation apparatus consists of rows of Woulfe's bottles or jars, partly filled with water; care is taken that the first pair of jars is placed in a tank of cold water. The condensation of the last portion of the hydrochloric acid gas is effected by the aid of coke columns or in leaden chambers, into which fine jets of cold water are injected on all sides of the column or leaden chambers. Commercial muriatic acid has a yellow color, the color being due to chloride of iron; the taste of this acid is a caustic sour, and it fumes by being exposed to the atmosphere; when pure it is colorless, and strong sunshine will decompose it. For the above reasons it should be kept in a dark place and well stopped up; all substances that it comes in contact with rapidly corrode, and its fumes will destroy colors. When this acid is exposed to the atmosphere it emits white fumes, which is muriatic-acid gas with a little watery vapor; therefore exposure will weaken the acid, and ought to be avoided as much as possible. Water is capable of absorbing 475 times its own bulk of hydrochloric-acid gas, and a saturated solution contains 42.85 per cent. of gas, the specific gravity being 1.21. The table below will show the specific gravity of this acid at its various degrees of concentration, and the amount of pure acid (real gas) contained at 70°.

Specific gravity.	Degrees Baume.	Degrees Twaddle.	Percentage of Acid.	Specific gravity.	Degrees Baume.	Degrees Twaddle.	Percentage of Acid.
1.21	26	42	42.85	1.17	22	34	34.34
1.20	25	40	40.80	1.16	21	32	32.32
1.19	24	38	38.88	1.15	20	30	30.30
1.18	23	36	36.36	1.14	19	28	28.28

Specific gravity.	Degrees Baume.	Degrees Twaddle.	Percentage of Acid.	Specific gravity.	Degrees Baume.	Degrees Twaddle.	Percentage of Acid.
1.13	18	26	26.26	1.06	9	12	12.12
1.12	17	24	24.24	1.05	8	10	10.10
1.11	15.5	22	22.22	1.04	6	8	8.08
1.10	14.5	20	20.20	1.03	5	6	6.06
1.09	12	18	18.18	1.02	3	4	4.04
1.08	11	16	16.16	1.01	2	2	2.02
1.07	10	14	14.14	–	–	–	–

This acid is very largely employed for the manufacturing of sal-ammoniac, phosphorus, chloride of antimony, glue, and chlorine, for the preparation of carbonic acid, for the manufacture of artificial mineral waters; it is also employed in bleach-works, hydro-metallurgy, in beet-root sugar works, and, mixed with nitric acid, to form aqua regia, for dissolving various metals. The principal use made of this acid by the woolen-dyer is to prepare the tin solutions, such as the muriate of tin, nitro-muriate, and sulpho-muriate of tin. This acid in its purity is colorless, exposure to light changes it to a yellow color, and strong sunshine decomposes it. Sometimes salt, also sulphuric acid, is added to this acid, to give it weight and density. The salt may be detected by evaporating some of the acid in a saucer; if salt is present there will be a white residue left; if iron is present in the acid, by evaporating as above there will be a brown residue left.

Muriatic-acid gas is a colorless elastic fluid, possessing a pungent odor, and the property of irritating the organs of respiration. It destroys life and extinguishes flame. It reddens litmus very powerfully, and has the other properties of a strong acid.

Its specific gravity is 1.269. When this acid is subjected to a pressure of forty atmospheres, at a temperature of 50°, it is condensed into a transparent liquid, to which alone the

name of *liquid muriatic acid* belongs. Water, at a temperature of 69°, takes up 464 times its bulk of this gas, increasing its bulk one-third and about three-fourths in weight.

Muriatic gas consist of 1 equivalent of chlorine, 35.5, and 1 equivalent of hydrogen, 1=36.5, or of one volume of chlorine and one of hydrogen united together without condensation.

Table of the Quantity of Aqueous Muriatic Acid of Specific Gravity 1.2 of Muriatic Acid Gas, and of Chlorine in 100 parts of Aqueous Acid of different densities.

Specific Gravity.	Aqueous Acid of Sp. Gr. 1.2.	Acid Gas.	Chlorine.	Specific Gravity.	Aqueous Acid of Sp. Gr. 1.2.	Acid Gas.	Chlorine.
1.2000	100	40.777	39.	1.1102	55	21.822	22.426
1.1910	95	38.738	37.	1.1000	50	20.388	19.837
1.1822	90	36.700	35.	1.0899	45	18.348	17.854
1.1721	85	34.660	33.	1.0798	40	16.310	15.870
1.1701	84	34.252	33.	1.0697	35	14.271	13.887
1.1620	80	32.621	31.	1.0597	30	12.233	11.903
1.1599	79	32.213	31.	1.0497	25	10.194	9.919
1.1515	75	30.582	29.	1.0397	20	8.155	7.935
1.1419	70	28.544	27.	1.0298	15	6.116	5.951
1.1308	65	26.504	25.	1.0200	10	4.078	3.968
1.1206	60	24.466	23.	1.0100	5	2.039	1.984

NITRIC ACID=HNO_3.

This is an acid that abundantly exists in nature in combination with other substances forming nitrates. Nitric acid is manufactured from either nitrate of potash or nitrate of soda, but at the present time it is prepared from the nitrate of soda mostly, as it is cheaper and gives more density to the acid; consequently it will be of a higher specific gravity. To prove this, it has been found that one hundred pounds of nitrate of soda will produce eighty-two pounds of nitric acid, while one hundred pounds of nitrate of potash produces but sixty-

eight pounds, and it takes less sulphuric acid with soda than with potash. With potash it takes two equivalents of sulphuric acid, whereas less suffices with nitrate of soda.

The nitrate of potash or soda is placed in an iron retort, and heat is applied, and sulphuric acid is added to it by means of a tunnel connected with the retort, and the acid vapors are allowed to distil over through earthen pipes into glazed earthen flasks or jars, which are called receivers; it is then re-distilled in glass retorts and placed in a sand-bath, with heat applied under the sand-bath. The next process is the bleaching of the acid. The acid is usually of a yellow color, which is due to the presence of hyponitric acid, and if a colorless acid is wanted it must go through the bleaching process; but a description of the operation is too lengthy to insert here, and if given would be of no advantage to the dyer. This bleaching is only done when a pure acid is wanted, and then it has to go through a condensation process after the bleaching. There have been improvements made in the manufacture of nitric acid, especially bearing on a possibility of doing away with the process of bleaching and a better method of condensing the acid vapors, but these improvements have not been adopted. All practical chemists are well aware that the red vapors will appear only at the beginning and towards the end of the distillation of the nitric acid, and it is therefore only requisite to distil the acid fractionally to obtain on the one hand a red-colored acid (the *acidium nitroso-nitricum* of the pharmaceutists), and on the other hand to obtain a colorless acid which can be readily delivered to the market.

The nitric acid of commerce is generally of a very light-brown color, which is owing to a little peroxide of nitrogen that it contains.

The following table was made out by Sir H. Davy, giving the proportions of nitrous gas contained in nitric acid according to the shade of color. Thus, in one hundred parts: —

COLOR.	Real Acid.	Water.	Peroxide of Nitrogen.
A pale yellow has	90.5	8.3	1.2
A bright yellow has	88.9	8.1	2.9
A dark orange has.	86.8	7.6	5.5
A light olive has	86.0	7.5	6.4
A dark olive has	85.4	7.5	7.4
A bright green has	84.8	7.4	7.7
A blue green has	84.6	7.4	8.0

This table must have been the result of experiments upon strong acid only, for the color will be changed by dilution. If we should add water to an acid of a dark orange color, it would soon change to a yellowish green. The sun also changes the color of this acid, which is due to the decomposition of the acid, and the liberating of peroxide of nitrogen. We can try the effects of light upon this acid, by taking some of the colorless nitric acid, and placing it in the rays of the sun. After a short time we can observe the change. This experiment will show the necessity of keeping it in a dark place. The carboys should also be kept stopped up, so that it will not be exposed to the atmosphere, as, when so exposed, it loses its strength very rapidly.

"Nitric acid,	of 1.52	specific gravity,	boils	at 86° F.
"	of 1.50	"	"	at 99° "
"	of 1.42	"	"	at 115° "
"	of 1.42	"	"	at 123° "
"	of 1.40	"	"	at 119° "
"	of 1.35	"	"	at 117° "
"	of 1.30	"	"	at 113° "
"	of 1.20	"	"	at 108° "
"	of 1.15	"	"	at 104° "."

There is a fuming nitric acid, prepared by using one part of nitrate of potash, KNO_3 (saltpetre), and one part of oil of

vitriol. From this mixture there is obtained a reddish-yellow fluid, which consists of a mixture of nitric and hyponitric acids, and is known by the name of fuming nitric acid. When equal parts of nitrate of potash and sulphuric acid are taken, there is but one-half the nitric acid expelled, while the other half is decomposed into hyponitric acid and oxygen. The hyponitric combines with the nitric acid, thus forming the fuming acid. But when manufacturing nitric acid from nitrate of soda, by decomposition, there are two parts of sulphuric acid used to one part of the soda. By this method, all the nitric acid contained in these salts is obtained, and what remains in the retorts is bisulphate of soda. When soda is used, it is on account of its easy decomposition by sulphuric acid; but it is not necessary to use two parts of sulphuric acid to one of soda, for one and one-fourth to one and one-half parts of sulphuric acid have been found to be practically enough. This fuming acid is, at the present time, prepared by adding to common nitric acid such substances as will easily effect the decomposition of the acid. Sulphur has frequently been made use of for this purpose. Starch, however, is generally used. The following recipe for manufacturing fuming nitric acid was made use of by M. C. Brunner, and called Brunner's recipe: To one hundred parts of saltpetre, three and a half parts of starch are added. These are put into a large retort, into which is poured one hundred parts of strong sulphuric acid, sp. gr.=1.850. The distillation usually sets in without the assistance of heat; but towards the close of the operation, heat has to be gently applied. In this manner one hundred parts of saltpetre are made to produce about sixty parts of fuming nitric acid. The impurities in nitric acid are generally iron, sulphuric and muriatic acids, and nitre is used to give it density, and cause its specific gravity to be greater than it really is.

The general test for nitric acid in the dye-house is the hydrometer, but density is given by adding to the acid nitre, sulphuric and muriatic acids; and in order to find out these impurities, we must test them by some other way than by the

hydrometer. Nitre may be detected very easily, by taking a little of the acid and evaporating it to dryness, and if the acid is pure, there will be no residuum left. If it contains oil of vitriol, it may be discovered by taking some of the acid, and adding four times the amount of distilled water to it; then to this add a few drops from a solution of barytes, and if it contains any sulphuric acid, the barytes will cause a white precipitation to take place.

Muriatic acid and chlorine can be detected by diluting some of the acid; then add a trifle of nitrate of silver. The result will be a white precipitation if muriatic acid is present in the nitric acid. Iron is detected by evaporating a little of the acid. There will be a brown-colored substance left if there is iron in the acid; or, by adding some gall-water to the acid, a bluish-black color will then show in the acid and gall-water, if iron is present in the acid.

The specific gravity of nitric acid ranges from 1.422 to 1.550, and it contains from seventy-six to one hundred parts of acid in one hundred parts. The technical application of nitric acid is based on its property of oxidation when in contact with certain substances, the acid splitting up into deutoxide of nitrogen, hyponitric acid, and azone, the latter forming with the body which causes the decomposition of the acid, either an oxide or a peculiar compound; while the hyponitric acid, when organic substances are present capable of combining with it, forms the nitro compounds, such as nitro-benzole, nitro-naphthaline, nitro-glycerine, and nitro-cellulose, or gun-cotton. Silk, wool, feathers, horn, and the skin of the hands will be stained yellow by nitric acid, for which reason it is used to color silk yellow. If the acid is in contact with the above substances for any length of time, they will be completely decomposed, and partially converted into picric acid. Starch and sugar are converted into oxalic acid by the action of nitric acid; but a very dilute nitric acid will convert starch into dextrine, or British gum.

This acid acts violently upon indigo. It discharges its

color, for which reason it is employed in calico-printing to produce a yellow pattern on an indigo ground. It is used in woolen-dyeing, for making nitro-muriate of tin, and, in a diluted state, it is used for a discharge in woolen-printing, all the vegetable colors being changed by its action to a yellow.

Nitric acid is used in hat-making, to prepare a mercurial solution for dressing felt hats. It is used for the preparation of nitrate of iron, a mordant for dyeing silk black; also for cotton-yarn dyeing. It is employed to prepare picric acid from carbolic acid, and naphthaline-yellow from naphthaline. It is used in manufacturing nitro-benzole, nitro-toluol, and phthalic acid, and for the preparation of nitrate of silver, arsenic acid, fulminate of mercury, nitro-glycerine, &c.

Nitric acid is one of the five compounds formed between nitrogen and oxygen. These five compounds are: Nitrous oxide (or laughing gas), NO; nitric oxide, NO_2; nitrous acid (formerly hyponitrous acid), NO^3; hyponitric acid (formerly nitrous acid), NO^4; and nitric acid, NO_5; or thus:

NO, nitrous oxide.
NO_2, nitric oxide.
NO_3, nitrous acid.
NO_4, hyponitric acid.
NO_5, nitric acid.

The formulas, according to Berzelius, for the different nitric acids, are as follows:—

Nitric acid, NO^5.
Monohydrated (or nitrate of water), HO, NO_5.
Quadrihydrated (sp. gr. 1.42), HO, NO_5+3HO.

The monohydrated nitric acid is the strongest that can be procured. Nitric acid was discovered by Raymond Lully, about the middle of the thirteenth century, and its constituents by Cavendish, in 1784. Nitric acid is said to be present

always in the air of summer. The quadrihydrated nitric acid is what is used by physicians and apothecaries.

Nitro-Muriatic Acid or Aqua Regia=$NO_2\ Cl_2$, or $NO_2\ Cl$.

This acid is the *aqua regia* of the earlier chemists, and was so called from its property of dissolving gold. When nitric and muriatic acids are mixed together, they will mutually decompose each other, and according to the researches of Gay Lussac, the re-action of the two acids gives rise to two compounds, in variable proportions of nitric oxide and chlorine ($NO_2\ Cl_2$, and $NO_2\ Cl$), mixed with free chlorine, the nitric oxide and chlorine being analogous in constitution to hyponitric acid (NO_4), and the free chlorine mixed with the nitrous acid is analogous to nitrous acid (NO_3).

The power of nitro-muriatic acid to dissolve gold and similar metals that have a weak affinity for oxygen, is owing entirely to the free chlorine which is present in the mixture, and is in no way dependent upon the two compounds above referred to, as they remain entirely passive during the dissolving of the gold. The proportions of the acids mixed to produce aqua regia, according to the above chemical theory, would be two equivalents of nitric to six equivalents of muriatic acid, in order to have them entirely and mutually decompose each other, and the products would be the two compounds named above (nitric oxide and chlorine, free chlorine and water). Most dyers, when preparing their nitro-muriatic acid for dissolving tin, use one equivalent of nitric to three equivalents of muriatic acid, and one equivalent of nitric to six equivalents of muriatic acid; then add from one and one-half to two ounces of granulated tin to the pound of the mixed acid.

The United States standard formula for making aqua regia, is three equivalents of nitric to six equivalents of muriatic acid. If we assume that the proportions given by Lussac are correct, it follows that there is an excess of nitric acid employed in the United States formula. And according to the

same views, the proportion of free chlorine must be variable, dependent upon the relative proportion of the nitric oxide compounds to each other.

For every equivalent of $NO_2\ Cl_2$ formed, one equivalent of chlorine will be set free; and for every equivalent of $NO_2\ Cl$, two equivalents of chlorine will be evolved. Gay Lussac has not given us the precise circumstances that determine the simultaneous formation of the two nitric-oxide compounds alluded to above, neither has he pointed out to us their constant varying proportion to each other.

Nitro-muriatic acid is of a golden-yellow color, and has the smell of chlorine. In preparing this compound, the operator must not hold his head over the vessel containing it any length of time, as the fumes from it are very injurious. The solution, when first put together, emits a great amount of nitrous gas.

The solution of nitro-muriate of tin, should have a fine amber-yellow color, when to be used for coloring scarlets, but for yellows and crimson shades, it will do to have it a browner-yellow color, which color is brought about by having more tin added to the acids. (See article, nitro-muriate of tin.)

Oxalic Acid $= C_2O_3$.

This acid was formerly known as salts of sorrel, and was obtained from a plant, but now it is prepared from sugar and starch, by the actions of nitric acid on these two articles. To obtain this acid, one part of sugar, two parts of starch, four parts of nitric acid, and two parts of water, are put into a retort, when a violent action takes place; the nitric acid decomposes and oxidates the sugar and starch, red fumes are emitted, which show the presence of nitrous acid (NO_3); the solution in the retort is then evaporated to about two-thirds of the original amount; the crystals form as the solution cools; they are white-colored. These crystals are again dissolved, and evaporated the second time. Oxalic acid is also manufactured from caustic soda and sawdust.

Oxalic acid combines with different bases, and forms salts of various kinds, that are of great importance. In the laboratory, it is easily known from the alkaline or earthy salts. Oxalic acid often contains peroxide of nitrogen (NO_4), and Epsom salts. To detect the presence of the nitrogen in this acid, dissolve a small amount of the suspected acid, and add to the solution the smallest possible quantity of sulphate of indigo. If nitrogen is present, the indigo will be discolored. If it contains Epsom salts, you can detect it by heating some of the acids to redness upon a piece of platinum, and if it contains no Epsom salts, it all evaporates; otherwise it will leave a residue of a yellowish-looking substance upon the platinum. Epsom salts can also be detected by chloride of barium. There is often from three to seven per cent. of Epsom salt, and sometimes more, in the oxalic acid now in the market.

"Commercial oxalic acid is frequently rendered impure by the presence of oxalate of lime and oxalate of potash. When it is desirable to remove these impurities, and prepare a perfectly pure article, it can be done in the following manner: Crude oxalic acid is dissolved in the least possible quantity of hot absolute alcohol, in which salts of lime and potash are insoluble, and then filtered. In a few hours the oxalic acid crystallizes out nearly pure, and the mother-liquor may be employed for making oxalate of ammonia, or for dissolving a fresh portion of the crude acid. The crystals thus formed are allowed to drain, and are then dissolved in boiling distilled water, which removes any adhering oxalic ether, and leaves the acid perfectly pure."

"To prepare pure oxalate of ammonia, the alcoholic mother-liquor is diluted, either with fresh water or with the aqueous mother-liquor, from the oxalic acid crystals. It is heated to boiling and neutralized with ammonia. In this operation, much oxamid and oxamethan are formed, but they can be easily decomposed by acidifying the salt solution and boiling for a considerable time; after which it is filtered, and the fil-

trate rendered slightly ammoniacal, and allowed to crystallize. By crystallization, the oxalate is obtained pure and white." — *Chemical Review.*

Oxalate of potash (KO, C_2O_3). This salt is prepared by saturating the carbonate of potash (pearlash) with oxalic acid, and evaporated to crystallization. It contains one proportion of water.

Oxalate of copper (Cu, C_2O_3). This salt is prepared by digesting oxide of copper (Cu, O) in a solution of oxalic acid. This salt is of a light-green color.

Oxalic acid is used more than formerly, and can be used on more than one-half the colors now dyed upon wool, as it will combine with all the dyestuffs, and will add intensity to the color, besides giving it a more brilliant hue. It is used largely in coloring logwood blue on wool and woolen fabrics. It has been lately introduced in the coloring of scarlets and oranges; its particular use or benefit in these colors is, that it will prevent the wool from turning brown by the action of its sulphur on the tin contained in the spirits, as the tin cannot precipitate as a sulphide where oxalic acid is present. Oxalic acid is composed of carbon and oxygen, having a proportion of the second element between those contained in carbonic oxide and carbonic acid. It therefore contains 12 parts of carbon and 24 of oxygen, or 2 parts of carbon and 3 parts of oxygen, making its prime equivalent = 36.

There are some manufacturers of oxalic acid who, it is said, obtain oxalic acid on a large scale by heating a mixture of 112 lbs. of sugar, 560 lbs. of saltpetre, and 280 lbs. of sulphuric acid, thus producing 135 lbs. of oxalic acid, and 490 lbs. of *sal-enixum.*

There are many substances besides sugar that yield oxalic acid, by the action of nitric acid; for instance, rice, gum, wool, hair, silk, starch, potatoes, molasses, and numerous vegetable acids. Certain organic substances will yield this acid when heated with potash. Wood shavings and sawdust, if mixed with a solution of caustic potash, and exposed to a

heat above 212° Fahr., will be partially decomposed and converted into oxalic acid; and, at the present time, a large amount of the commercial oxalic acid is produced by heating caustic potash and soda with sawdust. As soda alone will not generate the acid, and potash being too costly to use alone for the purpose of generating the acid, Mr. Dale ascertained that by mixing 2 equivalents of soda to 1 of potash, the same result was obtained as would be if potash alone was used with the sawdust.

Oxalic acid is a colorless crystal, and has a strong sour taste. The crystals are slender, flattened, five-sided prisms; they will sublime at 180° Fahr., and do not melt until heated to 280° Fahr. They will dissolve in nine times their weight of cold, and in an equal weight of boiling water. Oxalic acid combines with salifiable bases, and forms salts called oxalates. The most interesting of these salts are the three *oxalates of potassa*, called *oxalate of potassa* ($K\,O, C_2O_3$), *binoxalate of potassa* ($K\,O, 2C_2O_3$), commonly called salts of sorrel, and the *quadroxalate of potassa* (*essential salts of lemon*). The two last-named are useful in removing iron moulds from linen, and so is oxalic acid. This acid has a strong affinity for lime, and will form with it an insoluble precipitate called oxalate of lime (CaO, C_2O_3), whenever the acid and lime are brought in contact in a solution of the two substances, for which reason oxalic acid is the best test for lime, and *vice versa*, that is, their solutions are, but when lime is sought for, oxalate of ammonia forms the most convenient test. The mutual attraction of the oxalate of ammonia and lime is so strong, that the former will even take the latter from sulphuric acid. By this we see how the addition of a soluble oxalate will disturb the transparency of a solution of sulphate of lime (Ca, O, SO_3). Oxalic acid is distinguished from all other crystallized acids, by the form of its crystals, and by its solution yielding a precipitate with lime-water, insoluble in an access of acid.

As we have said before, oxalic acid consists of 2 equiv-

alents of carbon and 3 of oxygen, making its prime equivalent 36; but when crystallized we must add 3 equivalents of water, $HO = 27$, thus making the equivalent of the crystals, 63. In accordance with those chemists who consider it a bibasic acid, we shall have to double these numbers. Anhydrous oxalic acid is not known to exist, for two equivalents of the water can be driven off by a regulated heat, by which the acid is made to effloresce; but the third cannot be expelled without destroying the acid itself.

It was first discovered that this acid was a poison by Mr. Rayston, in 1814, since which time it has been investigated in relation to its poisonous properties by the late Dr. A. T. Thomson of London, and Dr. Christison of Edinburgh; and since it has been found to be a certain and rapid poison, and is generally known as such, its use has become more frequent for committing suicide.

It is from the generic appellation, *oxalis*, that it takes its name, but in pharmacy it it called *acidum oxalicum*.

Gallic Acid $= C_{14}H_6O_{10}$; dried, $C_7H_3O_5$.

The process of converting nutgalls into gallic acid, is founded upon the fact that, when the galls, in the state of moistened powder, are exposed to the atmosphere, the tannic acid contained in them is gradually converted into gallic acid, with the absorption (as is generally believed) of oxygen, and the escape of an equivalent quantity of carbonic acid (CO_2). The gallic acid being freely soluble in boiling water, but sparingly in cold water, is extracted from the altered galls by decoction, and is deposited as the water cools, and by repeating the process of dissolving it after each deposition renders the acid more pure, but it cannot be obtained entirely colorless unless it is filtered through animal charcoal.

"Dr. C. Wetherill believed that gallic acid differed from tannic acid, simply by its containing water, and he conceived the idea of preparing gallic acid from tannic acid by the fixation of water in the gallic acid. This he brought about

through the aid of sulphuric acid: he mixed thirteen drachms of tannic acid with twenty-two fluid ounces of sulphuric acid, and four times as much of water; then heated the mixture to the boiling point; then allowed it to stand; after a few days an abundant precipitation of white gallic acid took place, the result of which, amounted to 87.4 per cent. of the tannic acid."—*American Journal of Pharmacy.*

Gallic acid crystallizes in delicate, silky crystals, which are of a slight brownish color, but when pure are colorless; they have no smell, and have a sourish astringent taste. They are, according to Bracannet, soluble in one hundred parts of cold and three parts of boiling water; they are very soluble in alcohol; they are soluble in glycerine in the proportion of forty grains of crystals to the ounce of glycerine, and this solution can be diluted with water to any extent without affecting the transparency of the solution.

When gallic acid is heated to 420° it gives out carbonic acid (CO_2), and is changed to pyrogallic acid ($C_{12}H_6O_6$). According to Pelouze, gallic acid when heated to 410° or 420°, is resolved completely into carbonic acid and pyrogallic acid, and the proportion of the latter acid produced ought to be nearly seventy-five per cent.

Gallic acid, like tannic acid, reddens litmus, and will produce a bluish-black color, with a solution of carbonate of soda and copperas (sulphate of iron), but the color will disappear if the solution is heated to 120° or above. This result was shown by Dr. Mahler to depend on the conversion of the gallic acid into metagallic acid, by the loss of the constituents of carbonic acid and water.

Gallic acid at one time was supposed to be the active principle of all vegetable astringents, but it lost this reputation when the properties of tannic acid became known. "Gallic acid has recently again come into notice, and is now thought by many physicians to be a more valuable astringent than tannic acid for arresting hemorrhages when taken internally, especially hermorrhage of the urinary passages."

Citric Acid $= C_{12}H_5O_{11}$.

The formula of this acid in a dry state is $C_{12}H_5O_{11}$, but when crystallized from its solution by merely cooling, it contains four equivalents of water, three of these equivalents are basic. The "British Pharmacopœia" gives the formula of the crystallized acid thus—$3HO,C_{12}H_5O_{11}+2HO$, thus giving it two equivalents of water of crystallization.

Citric acid is a white solid crystal, sometimes rather larger than that of tartaric acid, which it resembles; it remains hard and solid in a dry atmosphere, but becomes soft and moist in a damp atmosphere; its sp. gr. is 1.6. Its taste is strongly acid and almost caustic. When heated, it will dissolve in its own water of crystallization, and, at a higher temperature, it undergoes decomposition, becoming yellow or brown colored, and forms a very sour, syrupy liquid, which cannot be crystallized.

"By destructive distillation it gives rise to water, acetic and carbonic acids, carburetted hydrogen, and a voluminous coal is left."

Citric acid is soluble in about three-fourths its weight of cold water, and in half its weight of boiling water; it is soluble in alcohol, but insoluble in pure ether. A weak solution of it has an agreeable taste, but when so diluted it will not keep, as it undergoes spontaneous decomposition. Tartaric and citric acids are frequently adulterated by mixing one with the other, and grinding them into powder; this can be detected by dissolving a little carbonate of potash (pearlash) in one of the suspected acids, and if there is tartaric acid in the citric acid, the pearlash will cause a precipitate of cream of tartar (bitartrate of potash) to fall to the bottom of the test-glass.

Citric acid is that peculiar acid contained in lemons and limes, to which these fruits are indebted for their sourness. We also find this acid in the juice of the cranberry, red gooseberry, the currant, the strawberry, the raspberry, the tamarind, and the red elderberry. This acid abounds so much in

the latter berry, that M. Thibierge of Versailles, France, proposes it as a source for producing this acid instead of obtaining it from limes and lemons.

We are indebted to Scheele for a very simple process of extracting the acid from limes and lemons. This process consists, first, in saturating the boiling juice with chalk or whiting in fine powder, and the citrate of lime is allowed to settle. This citrate of lime is repeatedly washed with water, and then decomposed by diluted sulphuric acid; there is immediately formed an insoluble sulphate of lime (CaO,SO_3), and the disengaged citric acid remains in the supernatant liquor. This is carefully concentrated in leaden boilers, until a pellicle begins to form, when it is drawn off into other vessels where it cools and crystallizes.

The method of manufacturing citric acid, as a general rule, is the same as that for tartaric acid (see tartaric acid), with these exceptions: the citric acid is not subjected to so great a degree of heat, citric acid being liable to decomposition if subjected to too high a temperature; and in the process, the citrate of lime should be decomposed without delay, for if kept, for any length of time, it will undergo fermentation, which would destroy the citric acid. The products of this fermentation would be acetic and butyric acids, and carbonic acid and hydrogen would be evolved.

It is necessary to add occasionally a small proportion of sulphuric acid to the citric acid liquor, during the progress of its concentration. With the above exceptions, citric acid is manufactured by the same processes that tartaric acid is.

According to Mr. Parkes, a gallon of either lime or lemon juice, if the process is well conducted, will yield eight ounces of white crystals. But to obtain this amount, it depends on the proportion of citric acid contained in the juice, which is very variable. The more recently the juice has been extracted from the fruit, the better will be the quality of the acid. The juice, after it becomes stale, is quite sour, and does not con-

tain any citric acid, because of its having undergone the acetic fermentation.

There were some suggestions made in the "Chemical News," by Mr. Frederick Row, in which he stated that the lime or lemon juice imported, from which most of the acid is prepared, contains so much coloring matter, mucilage, and other impurities, as very much to impede the process, so that it became necessary to make repeated crystallizations and saturations, in order to render the crystals fit for the market. It seems that the acid imported has undergone concentration, for the obvious purposes of enabling it to keep better, and to reduce the expense of freighting.

Mr. Row states, however, that he has found that much of the difficulty may be obviated, by diluting the concentrated liquor, so that it shall have the strength of the fresh juice, by which operation much of the mucilage and other impurities, will be made to separate in a flocculent form, and the citrate of lime, and consequently the citric acid, will be obtained in a state of comparative purity.

"One hundred grains of citric acid saturate one hundred and fifty grains of bicarbonate of potash."

Citric acid, as well as tartaric and acetic acids, are seldom used in woolen dyeing.

Citric acid is used in calico-printing, both as a resist and discharge.

ACETIC ACID$=C_4H_3O_3$.

Acetic acid is of the specific gravity of 1.047, and contains thirty-six per cent. of *monohydrated* acetic acid (HO,PO_5). This is an acid liquor produced from wood, by destructive distillation and subsequent purification; and one hundred parts by weight contain thirty-three parts of the acetic acid ($HO,C_4H_3O_3$), which corresponds to about twenty-eight parts of the anhydrous acetic acid ($C_4H_3O_3$); but the concentrated acetic acid corresponds to at least eighty-four per cent. of anhydrous or the commercial acetic acid.

We shall consider but three grades of acetic acid, the glacial acetic acid, *acidum aceticum glaciale*, and the *acidum aceticum*, or pyroligneous acid, and the acetic acid of commerce.

The *acidum aceticum glaciale* acid, sometimes called *radical vinegar*, is a colorless, volatile, inflammable liquid, having a corrosive taste, and a acetous, pungent, and at the same time a refreshing odor. It crystallizes when exposed to a temperature of 34° Fahr., and will remain in a crystalline state until heated to 50° Fahr. "Its specific gravity is 1.063," but can be increased by adding ten per cent. of its weight of water, when its density will rise to the specific gravity of 1.066. This acid has the property of dissolving a number of substances, among which we will name camphor, resins, gums, albumen, and the volatile oils.

"Its combinations with salifiable bases are called acetates."

"A drachm of this acid, mixed with a fluid ounce of distilled water, requires for neutralization, at least nine hundred and ninety grain measures of *volumetric solution of soda*."

"If a fluid drachm is mixed with half a fluid ounce of distilled water, and half a drachm of pure muriatic acid, and put into a small flask with a few pieces of granulated zinc, and while the effervescence continues, a slip of bibulous paper wetted with a solution of subacetate of lead be suspended in the upper part of the flask, above the liquor, for five minutes, the paper will not become discolored."

This shows clearly the absence of sulphurous acid in this kind of acetic acid. It consists of one equivalent of dry acid =51, and one equivalent of water=9, making its prime equivalent=60.

The dry acid has been isolated by C. Gerhardt, who finds it to be a limpid liquid, heavier than water, and having the constant boiling point of 279°.

The process generally adopted by the British manufacturers of this acid, is as follows:—

"One hundred weight of purified acetate of soda, which had been previously deprived of water by fusion, and broken

up after cooling, was digested with sixty pounds of sulphuric acid, specific gravity 1.848, and then heated in a still till all the acetic acid was driven over." "This was re-distilled, in a chloride of calcium (CaCl), or else an oil-bath, with peroxide of manganese, and afterwards again distilled from charcoal and peroxide of lead, the acid thus procured being placed in ice, and in a great measure solidified; and the liquid portion being decanted, the solid residue, when melted, had the specific gravity of 1.067, and contained ninety-eight per cent. of the monohydrated acid."

This grade of acetic acid is not used in the dye-house, but is used by physicians, who apply it externally as a substitute for cantharides (blister paste), when a speedy blister is desired, in such cases as croup, sore throat, and other cases of internal inflammation. It is an excellent substance to eat out corns and warts.

TARTARIC ACID $=C_8H_4O_{10}$.

This acid is extracted from the tartar which collects upon the inside of wine-casks during the fermentation of the wine. This tartar, when purified and reduced to powder, is the cream of tartar of the apothecaries, and consists of two equivalents of tartaric acid united to one equivalent of potash (potassa).

Tartaric acid was first obtained, in a separate state, by Scheele, in 1770. His process consisted in saturating the excess of acid in the (bitartrate of potassa) cream of tartar with carbonate of lime ($CaOCO_2$), and decomposing the resulting insoluble tartrate of lime ($CaO,C_4H_2O_5$) by sulphuric acid (H_2SO_3), which precipitates in combination with the lime, and liberates the tartaric acid; the equivalent quantities being one of bitartrate of potash, and one of carbonate of lime (chalk)..

The process, when thus conducted, furnishes the second equivalent, or excess of acid only of the bitartrate. This second equivalent may be obtained by decomposing the neutral tartrate of potassa (potash), which remains in the solu-

tion after the tartrate of lime ($CaO,C_4H_2O_5$) is precipitated with chloride of calcium ($CaCl$) in excess. By double decomposition, chloride of potassium (KCl) will be formed in solution, and a second portion of tartrate of lime will precipitate, which may be decomposed by sulphuric acid together with the first portion. If the process is conducted in this manner, it will, of course, furnish twice as much tartaric acid as when the excess of acid only is saturated and set free.

The method adopted for manufacturing tartaric acid on the large scale, differs greatly from the above method. The decompositions spoken of above are effected in a wooden vessel, closed at the top (called a generator), which will hold about 2,000 gallons. This vessel is furnished with an exit-pipe for carbonic acid (CO_2), and with pipes entering the sides of the generator, for the admission of steam and cold water respectively. This vessel is filled one-fourth with water. Then 1,500 pounds of washed chalk (carbonate of lime) is added, and then the whole is heated by a jet of steam through the pipes in the side. It is then thoroughly mixed until a uniform mass is obtained. About two tons of tartar are now added by degrees, and thoroughly mixed. The carbonate of lime is decomposed; the carbonic acid escapes through the exit-pipe, and the lime unites with the excess of tartaric acid, to form tartrate of lime, which precipitates; while the neutral tartrate of potash remains in solution. The next operation is to decompose the tartrate of potash, so as to convert its tartaric acid into tartrate of lime. This is accomplished by the addition of sulphate of lime (CaO,SO_3), made into paste, and, by double decomposition, will form a fresh portion of tartrate of lime, while sulphate of potash remains in solution. This solution, when it becomes clear, is drawn off into suitable vessels, and the precipitate (which is tartrate of lime) is washed several times in cold water. These washings are preserved, to use again for the same purpose. The tartrate of lime, mixed with sufficient water, is now decomposed by the proper amount of sulphuric acid, which forms sulphate of

lime, and liberates the tartaric acid, which remains in the solution. It is all now drawn off into a wooden tank, lined with lead, with a perforated false bottom. This is covered with stout twilled flannel, and serves for a filter. The solution filters through, and is carried by a pipe going from beneath the false bottom to suitable reservoirs. The whole liquor is evaporated in order to crystallize. Then this liquor is evaporated to the specific gravity of 1.5 ($1\frac{1}{2}$ degrees). It is drawn off into sheet-lead cylindrical crystallizing vessels, that hold five hundred pounds of the solution each. These crystallizing vessels are placed in a warm situation, and, in the course of three or four days, a crop of crystals is produced in each, averaging two hundred pounds. These crystals are somewhat colored, so they have to be purified by re-dissolving in hot water. The solution is then run through animal charcoal, filtered, again concentrated and crystallized. The crystals are now washed and drained, and finally dried on wooden trays lined with sheet-lead, placed in a room heated by steam.

Dr. Price of England made some great improvements in the above process, which are described in detail in the "London Pharmaceutical Journal and Transactions" (January, 1854, page 315).

Liebig prepared tartaric acid artificially by the oxidation of sugar of milk and other substances, by nitric acid. The resulting product was found to be identical in all respects with the tartaric acid obtained from grapes.

Tartaric acid is a white crystallized substance. It is not affected by the atmosphere. It has a strong acid taste; but when diluted with water, it has a very agreeable and cooling taste, not unlike lemonade. It is soluble in an equal amount of cold water, and in half its weight of boiling water. It is also soluble in alcohol. It combines with several of the vegetable organic alkalies, so as to form salts. Its usual impurity is sulphuric acid, which can be detected with acetate of lead ($PbO,C_4H_3O_3$). By adding a small quantity to a solution

of tartaric acid, a precipitate will be formed that is only partially soluble in nitric acid.

Tartaric acid, when dry, consists of four equivalents of carbon, two of hydrogen, and five of oxygen, making its equivalent sixty-six, thus:

$$4\,C=24,$$
$$2\,H=02,$$
$$5\,O=40=66,$$

and, when crystallized, of one equivalent of dry acid, 66, and one of water, $9 = 75$. But if we should agree with some chemists, who regard it as bibasic, these numbers must be doubled, and the formula of the dry acid would be $C_8H_2O_{10}$, and, in its crystallized state, $2HO,C_8H_2O_{10}$. Taking this view, its ordinary salts, whether with one or two bases, consist of one equivalent of acid, and two of base; and, in the bitartrates of potash (potassa), one equivalent of base is replaced by one of water, as in the cream of tartar (bitartrate of potassa), the constitution of which would be expressed by the formula, $KO,HO+C_8H_4O_{10}$.

Tartaric acid is not used to a very great extent in woolen-dyeing, but it is employed largely in calico-printing, both as an auxiliary in the solution for printing, and as a discharge for alumina and oxide of iron, employed as mordants. Sometimes this acid is mixed with bisulphate of soda ($NaHSO_4$), to form a discharge in calico-printing. A piece of cloth dyed red or blue, to which, in certain parts, there is applied a mixture of tartaric acid, pipe-clay, and gum (the latter as thickening to give consistency), becomes immediately bleached when the cloth so prepared is immersed in a solution of bleaching powder, — chloride of lime (CaCl), or chloride of calcium.

TANNIC ACID (*Acidum Tannicum*) $=C_{18}H_5O_9+3\,HO$.

Pure tannic acid is a solid, uncrystallizable, slightly yellow colored substance. It is inodorous, very astringent to the

taste, but having no bitterness. It is very soluble in water. Much less soluble in alcohol and ether. It is insoluble in the volatile and fixed oils. The commercial tannic acid often has a decided odor. This is chiefly owing to the presence of the odorous principle of the nutgalls from which it is obtained. Pure tannic acid can be kept unchanged in the solid state; but its watery solution, when exposed to the atmosphere, gradually becomes turbid, and deposits a crystalline matter, which consists chiefly of gallic acid ($C_7H_3O_5$). During the change, oxygen is absorbed, and an equal volume of carbonic acid disengaged. But according to the researches of M. E. Robiquet, this change does not always take place, and, when it does happen, it is owing to the presence of *pectase* in the tannin. But if the solution of tannic acid were boiled for a long time, the *pectase* would lose its property of a ferment, and the solution could then be kept for an indefinite time without suffering a change.

Tannic acic, when exposed to a certain degree of heat, will partially melt, swell up, become black, take fire, and will burn with a very brilliant flame. By being thrown upon red-hot iron, it is entirely dissipated.

A solution of tannin will redden litmus, and it will combine with most of the salifiable bases. It forms with potash a compound which is but slightly soluble, and the tannin can be precipitated from its solution by potash, or its carbonates, if the solution is not too weak, although a certain amount of potash will cause the precipitate to re-dissolve.

Tannic acid, in combination with soda, is much more soluble than with potash, and this alkali does not precipitate the acid, unless the solution is highly concentrated with tannic acid. Ammonia has a re-action upon this acid, very similar to potash.

Very many of the metallic salts are precipitated by tannic acid, even in their uncombined states, especially such as copper, lead, silver, mercury, chromium, protoxide of tin, &c. With sesquioxide of iron (Fe_2O_3) it will form a black pre-

cipitate, this being a compound of tannic acid and the sesquioxide, this compound being the basis of ink.

Tannic acid will unite with all the vegetable organic alkalies, and form compounds which, as a general rule, have a whitish color, and are very slightly soluble in water, but are soluble in acetic acid ($C_4H_3O_3$) and alcohol. In this latter respect it differs from most of the compounds which tannic acid forms with other vegetable principles.

"The ultimate constituents of tannic acid are, carbon, hydrogen, and oxygen, and its formula, according to Liebig, is, $C_{18}H_8O_{12}$, or $C_{18}H_5O_9+3\,HO$; to Berzelius, when made from galls, $C_{54}H_{19}O_{31}+3\,HO$. Muller, however, from recent investigations, considers that it is isomeric with gallic acid, and gives its formula thus: $C_{28}H_9O_{17}+HO$. Strecker looks upon it as a compound of gallic acid and sugar, and has for its formula, $C_{54}H_{19}O_{31}$, for the anhydrous acid, which by the addition of three equivalents of water, becomes the hydrated acid, $C_{54}H_{22}O_{34}$, differing from Liebig's by two equivalents of water."— *Chemical Gazette, No. 287, p. 370.*

From thirty to thirty-five per cent. of tannic acid is obtained from nutgalls by Pelouze's method, while Leconnot's method is said to yield sixty per cent. Mr. H. R. Bowman, of Philadelphia, obtained 80.07 per cent. of tannic acid from selected nutgalls.

All kinds of tannic acids are, when in contact with alkaline solutions, such as lime-water, caustic potash, ammonia, and with the simultaneous presence of air, decomposed and converted into brown-colored substances.

There is a drug similar to cutch, that contains from thirty to forty per cent. of tannic acid. This substance is extracted from the following plants, and called kino:

African kino, from	*Pterocarpus erinaceus.*
East India kino, from	*Pterocarpus Marsupium.*
West India kino, from	*Coceolaba uvifera.*
Australian kino, from	*Encalyptus resinifera.*

This substance is met with in the market in angular, brittle masses, of a brown-red color, sometimes of a blackish color. When it is ground into powder it is always of a brown-red color. It is quite soluble in hot water, also in alcohol, and yields a blood-red solution, having a very astringent and sweet taste. It is as valuable for coloring cotton as cutch, but is not so common or plentiful in the market; in fact, it is scarcely found in commerce, except at the druggist's.

In the investigations of Pelouze upon tannin, he found that if it were kept from exposure to the atmosphere, there would be no change effected in its properties; but if it was exposed to the atmosphere, it would imbibe oxygen, and the tannin would be changed to gallic acid; for which reason he concluded that gallic acid did not exist in very minute quantities in vegetables, and the supposition that tannic and gallic acids existed together in vegetables, arose from the process which was adopted to procure gallic acid, this process being to allow the macerated vegetable matter to be exposed to the atmosphere until the gallic acid should crystallize from the solution, this being nothing more than converting tannin into gallic acid by the absorption of oxygen.

More recent investigations have shown us that tannin is convertible into gallic acid, by much more rapid means than the above process. These means are by the processes of fermentation. "The action which is considered to take place during the fermentation of the tannin, by exposure to the air, is that it absorbs or combines with eight proportions of oxygen from the atmosphere." — *Pelouze.*

It requires considerable time for a solution of nutgalls, exposed to the air, before its tannin will be converted into gallic acid; but by adding tartaric or malic acids to the solution, it will cause the formation of gallic acid to proceed more rapidly.

"It has long been known that gallic acid does not precipitate copperas, when it is kept from exposure to the atmosphere. Persoz, Chevreul, and Berzelius observed that gallic

acid, when it was mixed with a salt of the peroxide of iron (Fe_2O_3), is always reduced to the state of a proto-salt."

"This is easily proved, by adding to the blue solution caused by the admixture of gallic acid and iron, an excess of acetate of lead ($CaO,C_4H_3O_3$), or of carbonate of lime ($CaO\ CO_2$), which precipitates the blue combination, and at the same time the sulphuric acid contained in the persulphate of iron, a colorless liquid, is separated by filtration, in which the presence of iron may be demonstrated in the state of a protoxide (FeO)."

"These experiments are insufficient to explain this curious re-action. It is not improbable to admit that the oxygen, combining with the gallic acid, converts it into a new acid of a blue color, yet positive experiments are wanting to decide the point."

"When a solution of gallic acid is poured by drops into a solution of persulphate of iron ($Fe_2O_33SO_3$) in excess, no blue coloring is obtained; if there is one produced it is but momentary. Nor is there one formed with the same salt in minimum in presence of chlorine, nor with a proto-salt of iron (copperas) and gallic acid oxidized in various degrees by chlorine, or by a salt of silver (AgO,NO_5=nitrate of silver), or lastly, by the atmosphere in an alkaline solution of gallic acid. When a solution of gallic acid is poured into a solution of the persulphate of iron, and the liquid is thrown down by the acetate of lead ($PbO,C_4H_3O_3$ = sugar of lead), there will be a blue paste precipitated, and if this precipitate is treated with oxalic acid (C_2O_3+3HO) it forms the soluble oxalate of iron (FeO,C_2O_3+4HO), the blue color entirely disappears, but can be brought back to blue again by adding a little acetate of soda ($NaO,C_4H_3O_3$)."

To prove in the most positive manner that the blue coloring is not to be ascribed to a blue acid, M. Barreswil endeavored to obtain other blue salts from gallic acid, by the use of sulphuric acid. He prepared some mixtures of the protosulphate of iron and the persulphate of iron, in variable propor-

tions, and to avoid the separation of the two above-named salts of iron, from their different degrees of solubility, he removed, as soon as possible, the water, by adding to the solution concentrated sulphuric acid, largely in excess, avoiding raising the heat as much as possible. In this manner he obtained a thick paste of a *deep blue*, the hue of which was more or less pure according to the proportion of the two salts of iron. He also produced a blue sulphate by evaporating rapidly a mixture of the two salts of iron; the blue tint appeared at the moment when the mass was nearly dry. His next experiment was to use phosphate of soda ($2NaOP_5O$) in place of the sulphuric acid. The result was a deep blue phosphate of iron ($3FeOPO_5$), and some sulphate of soda ($NaSO_3$), which removed the water immediately. In all his experiments the hyposulphite of soda (NaO,S_2O_2+7HO) alone afforded an intense blue coloring. This is not surprising; there are numerous instances in chemistry of bases which will combine with certain acids, but will not unite with others, among which is the protoxide of copper (CuO).

ACETIC ACID OF COMMERCE.

This acid is very similar to the glacial acetic acid in its properties, but milder in degree. It is a colorless, volatile liquid, and has a sharp taste and pungent smell. It will unite in all proportions with water, and, to a certain extent, with alcohol. It is entirely volatilized by heat, and yields no precipitate with either nitrate of silver ($AgNO_5$) or chloride of barium ($BaCl$). Sulphohydrate of ammonia (NH_3HS) will not discolor it.

This acid is sometimes contaminated with empyreumatic oils, which is due to the method of manufacturing. If there is much of this impurity in the acid, it will betray itself by the taste and smell; but if it is too minute to be detected by

smell or taste, the test for its detection, according to Mr. John Lightfoot, is to neutralize the acid with carbonate of potash (KO,CO_2) and adding a solution of permanganate of potash (KO,Mn_2O_7) ; and if the acid is pure it will retain its color, but if it is not pure the permanganate of potassa will be decolorized, and after standing a while there will be a brown precipitate fall to the bottom of the solution. If sulphuretted hydrogen (HS) is added to a solution of acetic acid it will produce a milkiness, if sulphurous acid (SO_2) is present. When saturated with ammonia (NH_3) the acetic acid will not precipitate with either the iodide (KI) or the ferrocyanide of potassium (K_4FeCy_6), showing the absence of lead and copper in the acid.

Of the United States acetic acid (specific gravity 1.047) "100 grains will saturate 60 grains of crystallized bicarbonate of potassa (potash, $KO2CO_2+HO$), and contains 36 grains of monohydrate acetic acid" ($HOPO_5$). This, we see, corresponds exactly with the percentage given in the table of specific gravities for acetic acid. Of the British acetic acid of commerce (specific gravity, 1.044) the strength in the anhydrous acetic acid is 28 per cent. ; in strength of monohydrated acetic acid it is, according to the table, 33 per cent.

It is very difficult to ascertain the strength of acetic acid by saturating it with the carbonated alkalies, if the operator depends upon test-paper for ascertaining the point of neutralization. The difficulty is caused by the acetates of potash and soda being alkaline to test-paper ; although they are neutral in composition, the liquid begins to be alkaline to test-paper, while some free acid remains, but insufficient to overcome the alkaline re-action of the salt formed by the combination ; therefore, by the use of test-paper, the strength of the acid is always underrated. The degree of inaccuracy, where test-paper is used, would be much diminished if the acid was saturated with a solution of saccharate of lime (sugar and slacked lime, dissolved in distilled water) of a known strength, as is proposed by Mr. C. G. Williams. A

still better way, according to Prof. Redwood, is to add to the acid a weighed excess of carbonate of baryta (BaO,CO_2), and to calculate its strength by the amount of carbonate which is decomposed, ascertaining by deducting the undissolved carbonate from the total amount used. E. C. Nicholson and D. S. Price say ("Chemical Gazette") that equally accurate results may be obtained by using carbonate of lime (chalk) in a similar manner. The acetic acid of commerce is the kind employed by color-mixers for reds, pinks, purples, &c., in combination with other substances; it is also used sometimes as a discharge, but not so general as tartaric acid.

Crude Acetic Acid, or Pyroligneous Acid.

The specific gravity of this acid ranges from 1.044 to 1.047, and is obtained by the destructive distillation of wood, and is called crude *pyroligneous* acid.

Wood, when charred, yields a number of volatile substances, among which are an acid liquor, creosote, tar, and a variety of other substances, some of which have very singular properties, which properties some eminent chemists suppose might be made serviceable in dyeing; but as yet, crystallized acetic acid ($C_4H_3O_3+HO$) and pyroligneous acid ($C_4H_3O_3$) are the only grades of acetic acid used, and these are not made use of in woolen-dyeing; but in calico-printing and cotton-dyeing these two substances are extensively employed.

The carbonization of wood in closed vessels for the purpose of manufacturing crude acetic acid (pyroligneous acid) was first put into extensive practice by Mollerat of France, and is thus described by Thenard: The method consists of, first, a furnace with a movable top; second, a strong sheet-iron cylinder, standing upright, large enough to hold a cord of wood, and furnished with a sheet-iron cover; third, a sheet-iron tube proceeding horizontally from the upper and lateral part of the cylinder to the distance of about one foot; fourth, a copper tube connected with the sheet-iron tube, which is bent in such a manner as to plunge successively to

the bottom of two casks filled with water, and, after rising out of the second, is bent back, and made to terminate in the furnace. At the bottom of each cask the tube dilates into a ball, from the upper part of which another tube proceeds, which, passing water-tight through the cask, terminates above a vessel intended to receive the condensable products. The sheet-iron cylinder being filled with wood (some manufacturers in this country use sawdust instead of wood), the cover is then put on and luted with fire-clay, and let down into the furnace by the means of a crane. The fire is then applied to the furnace, and when the process is completed the cylinder is hoisted out, and another lowered into the furnace, filled as before. During the carbonization, the volatile products are received by the tube, and those which are condensable, being an acid liquor and tar, are condensed by the water in the casks, and collected in the lower bends of the tubes, from which they run into the several receivers, or reservoirs, while the incondensable products, being inflammable gases, are discharged into the furnace, where, by their combustion, they assist in keeping up the heat in the furnace. Eight hundred pounds of wood afford, on an average, thirty-five gallons of acid liquor, which weighs about three hundred pounds. This is the crude pyroligneous acid, sometimes called *pyroligneous vinegar*, although it was long since known that it is simply acetic acid (or vinegar). It is a dark-brown liquid, having a strong, smoky smell, and consists of acetic acid diluted with water, and holding in solution tar and pyroxylic spirit (C_2H_3O+HO = methylic alcohol), and a small proportion of creosote ($C_{14}H_8O_2$).

It is from this crude acid that the acetic acid of the United States and Great Britain is prepared by purification, which is effected as follows: The crude acid is saturated with what is termed a cream of lime, which forms acetate of lime ($CaO, C_4H_3O_3$) in solution, and a large amount of tarry matter is precipitated. This solution of acetate of lime is then mixed with a concentrated solution of sulphate of soda ($NaSO_4$),

and, by double decomposition, acetate of soda is formed in solution, and sulphate of lime (CaO,SO_3) is precipitated. The solution of acetate of soda is next subjected to evaporation. During this evaporation the impurities that separate on the surface are skimmed off. The solution, being properly concentrated, is set aside to crystallize, and the impure salt thus obtained, after being partially purified by solution and re-crystallization, is fused in an iron vessel, stirred until it dries and, the heat is carefully raised and subjected to incipient carbonization, whereby the remaining empyreumatic matters are carbonized with little if any damage to the crystals. The mass is then all dissolved in water, and the solution, being strained and re-crystallized, is pure acetate of soda; this is distilled with thirty-five per cent. of its weight of sulphuric acid, thus yielding the acetic acid of commerce, the residue being sulphate of soda, its final process being filtration through animal charcoal.

Sometimes, in the above process, the acetate of lime is directly distilled with sulphuric acid without being first converted into acetate of soda, thus saving one operation in the process, but by this operation the acetic acid is apt to contain sulphuric acid; besides, it is attended with very many inconveniences. The same operation is saved, and it is without the risk of having sulphuric acid in the acetic by distilling the acetate of lime with hydrochoric acid (HCl, muriatic acid), as is recommended by Christl, and if the hydrochloric acid is not in excess, the acetic acid obtained scarcely contains a trace of chlorine (Cl).

M. Richter prefers the acetate of baryta ($BaO,C_4H_3O_3$) to the acetate of soda, because the fusibility of the soda will interfere with the operation, but adds to the baryta salt two per cent. of the acetate of soda, in order, to some extent, to obviate its tendency to become pulverulent.

The specific gravity of the different acetic acids increases with their strength up to the density of 1.0735 (maximum),

after which it decreases until it reaches 1.063, which is the density of the strongest acetic acid (being the *glacial acid*).

The following table, which is condensed from one given by Pereira, on the authority of Mohr, shows the specific gravity of acetic acid of different strengths. This table includes the United States officinal *Acidum aceticum dilutum*. The column on the left gives the percentage of monohydrated acid in each :—

Per cent. of Acid.	Specific gravity.	Per cent. of Acid.	Specific gravity.
100	1.063 Acetic acid (glacial).*	33	1.044 British acetic acid of commerce.
99	1.065 Glacial acetic acid.†	32	1.042 Scotch acid of commerce (strongest.)
97	1.068	31	1.041 Acetic acid, United States, 1850.
90	1.073	30	1.040
80	1.0735 Maximum density.	25	1.034 Pyroligneous acid (Edinburgh).
70	1.070	20	1.027
60	1.017	10	1.015
59	1.066 Strong acetic acid.	6	1.008 Diluted acetic acid (British).
54	1.063 Acid corresponding in sp. gr. to the strongest.	5	1.006 Diluted acetic acid (United States).
52	1.062	4	1.0055
50	1.060	3	1.004 Diluted acetic acid, United States, 1850.
40	1.051		
39	1.050 English acid of commerce.		
36	1.047 Acetic acid of United States.		

Up to the specific gravity of 1.062 the density of acetic acid is a very accurate index of its strength, but above that specific gravity two acids of different strengths may coincide in density. We see by the table that an acid of 1.063 may be either the strongest possible liquid acid, or an acid that contains only fifty-four per cent. of such acid. This ambiguity can be removed by diluting the acid with a portion of water, and, if the density is increased, that acid which increases in density is the strongest of the two having the same density

* This varies to 1.065.

† British.

before the water was added. This is the test in the British Pharmacopœia, of adding ten per cent. of water to their glacial acetic acid.

The density of the Scotch and English acetic acids of com merce is given upon the authority of Dr. Christison.

Part Second.

A DESCRIPTIVE ACCOUNT

OF

THE PROPERTIES AND COMPOSITION OF THE VARIOUS DYEWOODS AND SUBSTANCES WHICH ENTER INTO THE COMPOSITION OF COLORS.

DESCRIPTION OF DYEWOODS, ETC.

ORCHIL, OR ARCHIL.

This article comes to the dyer in casks containing a crimson-colored liquor and a large amount of weed. This weed is called by botanists *Lichen roccella* and *Roccella tinctoria*, a species of moss or seaweed, and is found in Sweden, Ireland, Wales, and the Cape de Verde Islands; the best is from the latter place. It is found in commerce in two forms: 1st, as a red pasty matter, having an alkaline taste, and called archil; 2d, as a red-violet powder, called cudbear. Some twelve years ago there was two preparations of archil brought into market under the names of orchil carmine and orchil purple; these preparations contained the archil in a very pure state. Archil is chiefly prepared in England and France; the method of preparing it has been kept a secret, and at the present time is imperfectly known; but what is known of the mode of preparation is that the lichen or weed is first ground to a pulp (after having been well dried); the pulp is then placed in wooden troughs with close-fitting covers to them; this pulp is then sprinkled with ammonia (NH_4), lime (Ca) and urine, which causes fermentation; it is stirred up at intervals and more ammonia added. It requires from six to eight days to develop the color; it is then put up in casks and sent to market, and is thus received by the dyer.

When it is two years old its coloring principle or properties are fully developed; after that time it begins to deteriorate. Archil gives very blooming but at the same time very fugitive colors. It is not now used in woolen-dyeing, as formerly, being superseded by cudbear, but is still used in silk-

dyeing for such colors as lilac, lavender, and other shades ranging between pink and purple; it is used to give a ground or bottom to silk that is to be colored safflower-pink. The silk is passed through a weak solution of archil, so as to form a flesh or light lavender color; the depth is regulated according to the shade of pink wanted. The silk is then passed through the safflower solution, to which has been added enough sulphuric acid (H_2SO_4) to make it slightly acid. When the color of the solution has become exhausted, the silk is worked in cold water, and then finished by passing it through water made acid with either citric acid ($C_4O_4H_2$) or tartar (CH_2O_2). Acetic acid ($C_4O_3H_3$) or sulphuric acid should not be used in the last process. The coloring principle of archil has been very extensively investigated in this country and Europe by some of the best chemists, and the results of their investigations have been that the coloring principle of archil depends upon the oxidation of a colorless base, or a certain compound which exists in the plant. This compound they termed *orcine* ($C_7H_8O_2$), and the oxidized color was called *orceine* ($C_7H_7NO_3$), which constituted the essential coloring of the archil. Since the discovery of the tar colors, archil has become almost obsolete or done away with, for even silk-dyeing. Could the color given by archil be fixed permanently upon wool or cotton, its value would be inestimable, the colors being very beautiful but very fugitive. In 1857 Mr. Marnas of Lyons discovered a process to make a color from archil that was both beautiful and permanent, and called it the French purple.

It was produced as follows: "Powdered lichens are macerated in lime-water in order to render soluble the coloring matter which combines with the lime. After filtration, hydrochloric acid (HCl) is added, which saturates the lime and causes the coloring substance to separate in a gelatinous state, which is washed and dissolved in hot ammonia (NH_4). The solution is very slow, as it requires from twenty to twenty-five days and a temperature of 153° Fahr. The am-

moniacal liquid, which has become violet, is then precipitated by chloride of calcium (CaCl), a purple-lake is then produced which is the French purple."

The acids will change this purple to a bright red.

The alkalies will change this purple to a blue.

Rock salt will change this purple to a crimson tint.

Sal-ammoniac will change this purple to a ruby-red tint.

Crystals of tin will change this purple to a red tint.

Blue vitriol will change this purple to a cherry-red brown.

Copperas will change this purple to a red-brown precipitate.

Alum gives a brownish-red precipitate.

These reactions are nearly the same on archil in the crude state.

CUDBEAR.

This is archil in a dry, powdered state, and is of a lilac color. The color given by it is not so bloomy, yet it has a more permanent nature than archil. Although the colors given by it are fugitive, still it is used considerably in woolen-dyeing for giving the logwood blues the indigo shade, to bloom up the dahlias and all those shades that require a purple hue or tint to them, such as mulberries, peach-blows, puces, &c. It is used with camwood to bottom up for indigo-blues, so as to economize the indigo; it is also used for indigo-purples in topping off along with hypernic wood. The following recipe is used by many dyers to bottom for indigo-blue: For two hundred pounds of clean wool boil up thirty pounds camwood and fifteen pounds cudbear for one hour, then enter the wool and boil one hour, draw off the tub, take out the wool and extract it, then it is ready for the blue-vat. Cudbear has all the characteristics of archil, and re-agents have the same result on the one as on the other. Tartar (CH_2O_2) is the only mordant that is of any use with cudbear; it

brightens up the color and enables it to resist the fulling and scouring much better than it would if not used. Archil and cudbear colors fade rapidly by the action of the sun's rays, and by light and heat, turning it from its natural color to a dull fawn; and colors, when cudbear or archil enter into their composition, should be dried in the shade and preserved from the rays of the sun. Cudbear should be mixed with water into a paste before putting it into the dye-bath, otherwise it would float on the surface; it requires no boiling before the wool is entered into the solution.

Litmus is obtained from the same weed that archil and cudbear are made from; the only difference in the preparation of the three articles consists in the fermentation and oxidation being carried to further development, the result of which is that the red pigment (orcin) contained in the sea-weed is converted into a blue-colored material called azolitmine, having the following formula: —

$$\left.\begin{array}{l}\text{Orcin, } C_7H_8O_2\\ \text{Ammonia, } NH_3\\ \text{Oxygen, } {}_4O\end{array}\right\}\text{ yield }\left\{\begin{array}{c}\text{Azolitmine, } C_7H_7NO_4\\ \text{and}\\ \text{Water, } {}_2H_2O.\end{array}\right.$$

After the weed has fermented sufficiently, it is mixed with chalk and gypsum, then made into small, flat cakes resembling lozenges; is then dried and sent to market. Litmus is prepared the most extensively in the southern part of France, from the juice of the *Croton tinctorium;* this shrub being submitted to the action of the ammonia contained in the urine and stable-dung used to excite fermentation in the process of manufacturing litmus, causes it to assume the purple-red color. This purple-red color is changed to a yellow-red by weak acids, and will not return to its former color (purple-red color) by alkalies. Litmus could be used, and is sometimes used, as a coloring material, but it is too fugitive to be applied in coloring woolen fabrics; it is employed mostly for coloring test-paper, and giving a bluish tinge to whitewash;

also for coloring the red champagnes, &c. In Holland it is termed or called *tournesol en drapeaux*, and is used there for coloring the crust of certain kinds of cheese, as this coloring of the crust has an effect to keep off the cheese-mites and the cheese is less liable to decay. Litmus is also used for coloring a peculiar kind of paper used for covering sugar-loafs.

The lichens employed for obtaining archil, cudbear and litmus are different species of *Roccella*, *Lecanora*, *Variolaria*, and others. These lichens grow on maritime rocks in various parts of the world, but for commercial purposes are chiefly collected upon the European and African coasts. They are also obtained from the islands of Canaries, Azores, Madeira, and Cape de Verde.

The particular species employed are probably *Lecanora tartarea*, or *Tartarean moss*, growing in the north of Europe, and *Roccella tinctoria* or *orchilla weed*, which abounds upon the African and insular coasts, and is called commercially, in common with other species of the same genus, *Angola weed*, *Canary weed*, &c., according to the name of the place from which it may be brought. All of the three coloring substances named above can, however, be obtained from either one of the species of the plant. The litmus-paper of commerce is prepared from one of the coloring substances of these plants (litmus), by first forming a strong, clear solution of one part of litmus to four parts of water, then dipping slips of white, unsized paper into it, or by applying it with a brush to one surface of the paper only; then the paper is carefully dried and kept in well-stopped jars, from which the light is excluded. Litmus-paper should have a uniform purplish color, bearing upon the blue shade, neither very light nor very dark.

Another method of preparing litmus-paper is to "digest for some time 20 grammes of litmus in 100 cubic centimetres of water, shake some time, and then filter. To the filtered liquid add a slight excess of nitric acid, and boil, and then exactly neutralize with potassa. Now make a weak solution

of gelatine by boiling one part of ichthyocolla in six parts of water, immerse in this solution some white, unsized paper, and afterwards hang it up to dry, then color one side of it with the solution of litmus." By gaslight it is said that the change of color cannot be determined by the eye exactly, as the blue of the litmus becomes a mauve color, but this can be obviated by watching the process through a green glass, by which means the faintest trace of blue will become discernible.

ANNOTTO.

Annotto is a shrub which was originally a native plant of South America, but is now cultivated in the East Indies and St. Domingo, and called by botanists *Bix orrellana.* It grows to the height of eight or ten feet, but never above twelve feet. The leaves are divided by fibres of a brownish-red hue, about four inches long, having a broad base, terminating in a sharp point. The stems are used by the natives to make ropes of. The shrub bears an oblong pod, resembling a chesnut-burr. At their first formation, they are a beautiful rose-color, and as they ripen, they become a dark brown, and then burst open, showing a crimson pulp, which contains three or four seeds similar to raisin-stones. The pod is then taken and stripped of its husks; the seeds are rubbed together in water, which deprives them of all impure matters contained in the seed; the coloring-matter is then allowed to settle, and the supernatant liquor is drawn off, and the coloring-principle, or annotto, left to dry, when it will change to a dark-brown color, having no taste, but a disagreeable odor when brought into market. The smell is not natural to the annotto, but is owing to the addition of stale urine, which is used to retain its moisture and color. Annotto is used by the Indians on the coast of the Carribbean Sea, to paint their bodies before going into battle, in order to terrify their enemies. They do

it by rubbing the seeds in oil, or some fatty matter, and making it into some sort of paste; then dry it in the sun for future use.

Annotto, when boiled, will give a syrupy solution of a yellow color, with the following re-actions:—

Alkalies will give a white precipitate of a clear orange color; an acid will change this to a redder shade. Muriatic acid (HCl) has no action upon it. Nitric acid (HNO_3) will decompose it, and form several compounds, which have not yet been fully examined. Sulphuric acid (H_2SO_4) and the solid annotto, will give a deep blue precipitate, but it changes to a dirty green, then to a dark purple color. Chromic acid (H_2CrO_4) gives a deep orange color. Soda-ash (Na_2CO_3) gives the best results in producing an orange with this article upon cotton; but all colors produced with annotto are fugitive, and although the acids or alkalies cannot destroy the color given by it, they will be constantly changing by exposure to light and air, for which reason it is not so much used as formerly, and at the present time it is not used in woolen-dyeing, but by some dyers it is used in coloring mixed goods, such as silk and cotton, silk and wool.

Annotto is dissolved readily in alkalies. The alkalies most in use for this purpose are potash, or soda-ash, and for light shades some dyers use soft-soap, instead of pot or soda ash. By mixing ammonia (NH_3) with annotto, and exposing it to the air previous to coloring with it, we obtain a much richer color. When it is thus mixed, a new substance is formed, which is termed *bixeine*, and will not crystallize, but becomes a sort of pasty matter, and is greatly improved by the admixture, giving a more full and rich orange shade. I do not assert that annotto cannot be crystallized, but that the substance termed *bixeine* is not crystallizable.

It was considered that annotto contained two distinct coloring-matters, but it has been shown by Preisser, that the one was the oxide of the other, and they are obtained by adding sulphate of lead ($PbSO_4$) to a solution of annotto; the lead

will precipitate the coloring-matter; then separate the lead from the precipitate by the use of sulphuretted hydrogen, and the substance being filtered and evaporated, the coloring-matter is deposited in small crystals of a yellow-white color. These crystals are *bixine;* they will become a deep yellow by exposure to the atmosphere, but by dissolving them in water you will prevent this change. These crystals (*bixine*) have the following re-actions:—

Sulphuric acid gives a yellow that does not turn blue as it does with annotto.

Nitric acid gives a yellow shade.

Chromic acid gives a deep orange tint.

If ammonia is added to *bixine*, with free contact of air, it will change the color from the yellowish-white to a fine deep red, like the annotto from which it was obtained, and it is then another substance, and is termed *bixeine*, which is not crystallizable, but it may be obtained as a red powder. Sulphuric acid turns this powder to a blue, and combines with alkalies, and is *bixine* with the addition of oxygen. Annotto is adulterated mostly with ochre and oxide of lead (Pb_2O). These adulterations may be detected by burning a given quantity in a porcelain crucible; if the annotto is free from the above minerals, there will be no residuum left, but if there is lead in it, if you keep the crucible at a red heat, there will be a small ball of lead at the bottom; and if ochre is the adulteration, there will be a red powder left.

Some dyers, when using annotto, make what is termed a stock liquor; that is, they dissolve a quantity of it in a barrel or some other vessel, and keep it for future use; but this is a bad practice, as the solution will soon become stale, and, consequently, loses a large amount of its coloring principle, for which reason it is better when freshly made up. A very good method for preparing it is as follows: To a barrel of water (forty-two gallons), add fifteen pounds of annotto, four pounds soda-ash, three pounds soft-soap, and boil until all is dissolved; but for nice light shades white bar-soap should be

used. Cotton cloth or yarn put into this solution is colored a dark orange color, but we can vary the shade from an orange to a cream color, by just varying the amount of the solution. The cloth or yarn requires no preparation or mordant, before coloring with the above solution. This method is for cotton-cloth, cotton-yarn, or warp. By passing the cloth or yarn through a weak solution of oil of vitriol, or, more properly speaking, a sour bath, the orange color will assume a scarlet or salmon color, according to the amount or depth of orange color on the cloth or yarn, previous to passing it through the acidulated bath.

BRAZIL-WOOD, OR HYPERNIC.

There are several varieties of this wood, and they are distinguished from each other by the name of the place from which they are obtained, such as Pernambuco, Japan, Nicaragua, &c. The last named wood is sometimes called Santa Martha wood. They all give a good red, and, in relation to dyeing, are considered as only different names for dyestuffs that produce similar coloring effect, the hypernic-wood giving a more blue tint to the red than the other kinds. The Pernambuco contains more coloring-matter than the others, although the hypernic is the same in quality, giving a rich crimson color to the solution, which the acidulous salts will change to an orange, and the alkalies to a purple. The salts of potash, soda, and ammonia will change the solution to a rose-color, which will soon pass away by standing. The salts of tin (or crystals of tin, $SNCl_2$) will throw down very slowly a bright, red-colored lake; and alum (SO_4Al_2) will have the same effect, only of a more decided and clearer red.

All these kinds of wood contain a coloring-matter called *brasiline*, or *brezilin* (formula, $C_{44}H_{40}O_{14}+3\ HO_2$), a colorless substance which will form crystals, the watery solution of which turns gradually to carmine-red by exposure to air, the

same change being almost instantaneous, either by boiling the solution, or by the action of alkalies. The world at large, as well as dyers, are greatly indebted to the French chemists for their valuable researches into the coloring-matters of these as well as other dyewoods. Chevreul long since obtained the coloring-matter from Brazil-wood by the following process: Digesting the ground wood in water until all the coloring-matter is held in solution, and then evaporating it to dryness, in order to get rid of a little acetic acid ($C_4O_3H_3$) that it contains. This residue is again dissolved in water. The solution is then agitated with (PbO) litharge, so as to deprive it of any fixed acid that it might contain. This solution is again evaporated to dryness. The residue is then digested in alcohol (C_2H_6O), pure. Afterwards the residual matter is diluted with (HO) water. Then there is added to this solution dissolved glue, until all the tannin which it contains is thrown down (or precipitated). Filter it again, and evaporate to dryness, and digest the residue in alcohol again, which will leave undissolved any excess of glue which might have been added. This last alcoholic solution being evaporated to dryness, leaves *brezilin*, the coloring-matter of the wood in a state of purity.

The re-agents act upon brezilin as follows: —

Copperas (SO_4Fe) gives a dark purple, not changed by standing.

Nitrate of iron ($3NO_62Fe$) changes it to a crimson.

Chloride of tin ($SNCl_2$) changes it to a very deep crimson.

A hot solution of ($SNCl_2$) to a deep red precipitate.

Acetate of copper ($1C_4O_3H_32Cu$) will give a dark purple.

The action of chromic acid (H_2CrO_4) is very remarkable on the brezilin. We find that they will decompose each other, and produce a beautiful yellowish brown.

The action of bichromate of potash ($H_2Cr_2O_7$), with a decoction of Brazil-wood, has long been taken advantage of in calico-printing, and I think, by a proper modification, it might be advantageously applied in the woolen dye-house.

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These remarks upon the pure coloring-principle of Brazil-wood (brezilin) are applicable to the wood in its rough state. My opinion is, that the pure coloring-matter of these, as well as other dye-woods, are oxides of a colorless base. Thus, brezilin is the oxide of a base which is without color, and its composition is: carbon, 36; hydrogen, 14; oxygen, 14. Preisser terms, or calls, the pure coloring-principle of Brazil-wood brezilin, and that its composition is: carbon, 36; hydrogen, 14; oxygen, 12. By comparing the two, we find that one is converted into the other by absorbing two proportions of oxygen, and that the re-actions are allied to those of indigo and logwood. (See articles on indigo and logwood.)

Brezilin is very soluble in alcohol or water, but, from the hardness of the wood from which it is obtained, the brezilin cannot be extracted except by hard boiling, and not then completely. Alcohol is the only element that will extract all the coloring-matter from this wood, as well as from barwood and sanders. A decoction of Brazil-wood will have a deep red color, but changes into a rich yellow-red by standing. Acids will give it a yellowish color, and render it unfit for dyeing purposes. Alkalies give it a violet color, which is very fugitive.

The Brazil-wood tree, called by botanists *Cæsalpinia crista*, is a native tree of South America, and some authors give it the name of the country in which it is most abundantly found, — Brazil (see Southey's History of Brazil, vol. I.). It grows mostly in dry places, and amongst rocks. Its trunk is large, crooked, and full of knots. The following description of this dye-wood will be found in "Bell's Geography": —

"The Brazil-wood, known in Pernambuco by the name of *pao da rainha* (Queen's-wood), is now rarely to be seen within many miles of the coast, owing to the improvident manner in which it has been cut down by the government agents, without any regard being paid to the size of the tree, or its cultivation. It is not a lofty tree. At a short distance from the ground, numerous branches shoot out, and extend in

every direction in a straggling, irregular, and unpleasing manner. The leaves are small, and not luxuriant. The wood is very hard and heavy. It takes a high polish (the same as camwood), and sinks in water. The only part of it that is valuable as a dye is the heart of the tree (the bark having no coloring-principle in it). The name of this wood is derived from *brasas*, a glowing fire of coal. The leaves are pointed. It has blossoms of a whitish color, growing in a pyramidal spike (resembling the sumac-blossom). One species of the Brazil-wood has flowers, which are variegated with red, the branches being slender, and full of prickle-thorns. The wood known by the name of Pernambuco contains the greatest amount of coloring-matter. It is of a yellowish color when freshly cut, but turns red by exposure to the atmosphere. That kind called *Lima-wood* is the same in quality."

The action of the metallic salts has the same result on all these different-named woods, they being the same in nature as regards their coloring matters or principles. For cotton-thread dyeing with these woods (for reds) the proper mordant seems to be alum and muriate of tin (or tin spirits). But all the colors obtained from these woods are more or less fugitive, losing their brilliancy upon a short exposure to the atmosphere. The sun's rays have a powerful influence upon these woods; for this reason, all colors produced by them should be dried in the shade or on a drying-machine. When colors dyed with these woods are exposed to the sun's rays, they will in a short time have a blackish tint, and will pass to a brown, and after awhile fade away to a light dun color. These changes are thought to be caused by the coloring-matter being decomposed into water and some other volatile substance, leaving a part of the carbon free, which will produce the black tint. Notwithstanding all this, there is a large consumption of these woods, more especially for dyeing fancy reds on cotton-threads.

The hypernic wood is the best for coloring garnets, rubies,

and maroons on wool, on account of its not being such a decided red as the other woods.

BARWOOD.

This wood is brought principally from Sierra Leone and the equatorial regions of Western Africa. It is a hard, resinous wood, and is considered by some chemists to be the same as sanders or *saunders-wood.*

This dyewood is always received by the dyer in a ground state, as it would be almost impossible to extract its coloring matters by boiling in water if it was used in the chip. The wood is a bright red color, devoid of savor or smell, and imparts but a very slight color to the saliva; its coloring-principles are similar to camwood and sanders, but the color given by it is of a bluer cast than either of the last-named woods, and of a poorer and more feeble intensity, on account of the coloring-matters being more widely separated from each other on the colored fabric than those colored by camwood or sanders; yet it yields a coloring-matter that is permanent with or without a mordant (the same is applicable to the last-named woods), but the wool or cloth colored with barwood is not so harsh to the touch as if colored with either camwood or sanders. Barwood requires longer boiling than other woods to bring into solution all its coloring-principles, with the exception of camwood and sanders, the latter being harder and more resinous than barwood. Alkalies, astringents and alcohol, cause it to dissolve easily in water. Some botanists make a distinction between barwood and camwood, but the two woods are found in their chemical composition to be the same. To extract the whole of the color from fifteen grains of barwood, Preisser found that it was necessary to treat it several times with alcohol at a boiling heat. The alcoholic liquid contained 0.23 of liquid coloring-principle and 0.004 of salt.

Barwood contains 0.23 per cent. of red coloring-matter, whilst sanders contains 16.75 per cent. according to Pelletier. The alcoholic solution of barwood has the following re-actions:—

The fixed alkalies will turn it to a dark crimson or dark violet. Lime-water has the same action as the fixed alkalies.

Sulphuric acid (H_2SO_4) darkens the color to a cochineal red.

Muriate of tin gives a brick-red precipitate.

Tin crystals ($SNCl_2$) give a blood-red precipitate.

Protoxide of iron (FeO) gives a very abundant violet precipitate.

Cupric sulphate ($CuSO_4$), a violet-brown gelatinous precipitate.

Acetate of lead (PbA_2O_2), a dark violet gelatinous precipitate.

Pyroxylic acid ($C_2H_4O_2$) and alcohol act alike on barwood, and the strong colored solution behaves the same with the same re-agents.

Hydrated ether will dissolve 19.47 per cent. of the coloring-principle of barwood. Ammonia, potash, or soda added to a strong solution of barwood, will turn it to a dark violet color. In coloring wool with barwood, it must come in contact with the wool in order that all the color can be extracted from the wood, for which reason the wood is either thrown loose into the tub or kettle, or sprinkled upon the wool before it is thrown into the dye-tub. I think the best method for the use of barwood, in order to obtain the best results from the given amount of wood used is, to sprinkle the wood upon the wool before entering it, or, in other words, you must mix the wood with the wool, which can be done by spreading a layer of wool upon the floor of the dye-house, in front of the tub in which you intend to make the color; then sprinkle on a certain amount of the barwood; then a layer of wool, and so on alternately until you have given or used the amount of wood required for the color you are making. It will not do to put

the barwood in bags to boil out, as it will become solid or compact, and it will be impossible to extract all the coloring-matter from the wood, as the boiling water has no chance to saturate it and dissolve the coloring-matter. The coloring-matter of barwood, while at the boiling point, combines easily with wool or cotton that has previously been mordanted, the mordant taking up the coloring-matter of the barwood that is at that time in solution, and the water, thus exhausted of its color, will dissolve another proportion of the coloring-matter of the wood, which is again taken up by the wool or cotton, and so on until the mordant upon the material has become completely saturated with the color, and it is now at its brightest and richest color.

The above remarks are equally applicable to camwood and sanders. Barwood is not used for compound colors on cotton with the other red woods, but in woolen-dyeing it is. The coloring-matter of barwood has not been obtained in a crystallized state, but I am inclined to think that crystals can be obtained from it by a careful management of experiments made with that object in view, and I feel warranted to assert that the pure coloring-principle, or, in other words, the matter which creates a color, when united to a metallic or earthy salt, is an undefined crystalline body, and that it is this crystalline substance only that we require, in dyeing, to produce the most brilliant hues (the aniline dyes corroborate this assertion); and whenever that period in futurity arrives when the dyer can obtain, in a crystalline form, the coloring-matters of the rough dyestuffs which yield the pure reds, yellows, and blues, then all will be accomplished that the art of dyeing requires in this respect, because from these three coloring-matters every other shade or color in dyeing can be obtained by proper treatment and manipulation. Alcohol, alkalies, and matters or substances that contain tannin or the astringent principle, such as sumac, nutgalls, &c., all aid or facilitate the extraction of the coloring-matter from barwood, camwood, and sanders. I will here caution the dyer in

regard to the too careless practice of not washing out the tubs or kettles after coloring in them such colors as require saddening, for if the tub is not thoroughly washed out from this previous coloring, and you are going to use barwood, camwood, or sanders for your next color in the same tub, there will be more or less of the metallic salt left in the tub, which will prevent the woods from giving out or yielding up their coloring properties to water. Barwood is used with fustic, camwood, and madder, in woolen-dyeing for browns, brown olives, &c.

CAMWOOD.

This is another species of the red woods, and grows in Sierra Leone and those countries adjacent to the Bight of Benin, and has chemical properties and nature very similar to barwood and sanders, and is called by botanists *bois rouge, santal rouge*. It contains more coloring-matter or principle than sanders or barwood, and is a more permanent color. It comes to the dyer in a ground state, the same as barwood and sanders. The precipitates from a solution of this wood are of a more yellow cast, which explains why the colors dyed with it are so much more intense and rich than colors produced by the other red woods, on account of its color being more of a decided red. It is more extensively used in woolen-dyeing than either of the other red woods, for the reasons given above, and is similar to barwood. It will give a permanent color with or without a mordant. Camwood gives out its color with great reluctance, but by taking one-half ounce of soda-ash (Na_2CO_3) for every twelve pounds of camwood used, and adding it to the boiling solution just before the wool is thrown into the tub, it will make a great difference in the quantity of color obtained, and the wool will not feel so harsh (the same may be said in regard to barwood), and will card more open than if the soda-ash had not been used.

Camwood naturally gives a harsh feeling to wool, but not so much as sanders. Re-agents give the following results: —

Copperas (SO_4Fe) gives a plum color.

Muriate of tin gives a bright crimson-red color.

Blue vitriol ($CuSO_4$) gives a handsome-looking claret.

Alum (SO_4Al_2) gives the solution a beautiful red color.

Acetate of copper (verdigris) gives a light reddish-brown.

Nitrate of iron ($3NO_62Fe$) gives a reddish-brown.

None of the salts of lime seem to produce desirable results upon it as a mordant. Blue vitriol gives the best results or effects upon the color of this wood, and appears to be the most effectual mordant for it, especially if using it for browns.

CATECHU — SOMETIMES CALLED CUTCH.

This is a dry extract, prepared from a sensitive plant called *Terra Japonica*, and contains a large amount of tannin or astringent principle. It grows in the mountainous districts of Hindostan. It grows to about twelve feet in height. The trunk is about one foot in diameter, and covered with a thick, dark-brown bark. The extract is obtained in the following manner: The plant is cut down and all the exterior white wood cut into chips; these chips are put into unglazed pots, and enough water added to cover them; heat is then applied, and when half the water is evaporated the decoction is poured into a shallow earthen vessel and reduced two-thirds by boiling; it is then set away to cool for one or two days, then afterwards evaporated by the heat of the sun, it being stirred occasionally during that process. After it is reduced to a certain thickness it is spread upon mats that are sprinkled with the ashes of cow-dung. Strings are laid so as to divide this mass into quadrangular pieces; it is then completely dried in the sun, after which it is ready for the market. There is a catechu brought to this country from India, which

is in small, cubical-shaped masses, about one inch in size, but it is of inferior quality, and is easily known from the genuine. Sometimes means are employed to alter this inferior article, and cause it to be more difficult to detect. It contains a large amount of roasted starch, or dextrine. Good catechu is of a dark-brown color, or what is called a chocolate color, and has an astringent taste, with no odor or smell, and will all dissolve in water, and the solution is a yellowish-brown in color. Good catechu will contain about

50	per cent.	of Tannin,
8	"	of Gum,
35	"	of Extractive matter,
7	"	of Impurities in 100 parts.

There are different qualities of catechu in the market. We will mention but three of them—the Bombay, Bengal, and Malabar. The Bombay is found, or comes to the dyer, in square masses, of a reddish-brown color, and if broken will exhibit an unbroken texture. Its composition will be found as the above, nearly. This catechu (the Bombay) is said to be the best kind. The term extractive is an indefinite expression, and is designated as a brown matter that can be extracted from all vegetables by boiling, but its true nature is as yet comparatively unknown; yet the part it may have in the re-actions of catechu is perhaps important, and is not to be lost sight of in the use of this drug. Bengal catechu is found to be in flattish, round lumps, and its outside appearance is of a light-brown color; the inside is a very dark-brown color. Its composition is:

48.9	per cent.	of Tannin,
37.0	"	of Extractive matter,
7.5	"	of Gum,
6.6	"	of Impurities in 100 parts.

This catechu is extracted from the nuts of the *Areca catechu* plant. The Malabar catechu we will find in large masses; that is, it comes into the market in a solid mass, with a covering of leaves, and often there are leaves intermixed, or in layers throughout the whole sack, and comes in about one hundred pounds to the sack. The color of this catechu is a light brown upon the outside, but very dark inside.

These different catechus contain from thirty to fifty per cent. of tanning principle, or, we might say, tannic acid, or catechu tannic acid (formula, $C_{15}H_{14}O_6$); also a peculiar acid called catechutic acid ($C_{16}H_{14}O_6$), but the last-named acid is of but little use, either in dyeing or for tanning purposes.

Sometimes dealers will place or put into the market an inferior article of Malabar catechu (called kino) as the real Malabar, but it can be known by its being greatly broken up, and a large amount of fine-powdered adulterations of a brown-red color. It is soluble in hot water, the same as other catechus; but the solution will be of a more blood-red color, and will have more of an astringent and sweet taste than any other varieties of catechu. It contains but thirty per cent. of tannic acid ($C_{15}H_{14}O_6$).

Kino is used mostly for what is termed quick tanning, in the process of manufacturing leather from the raw hides. This kino, or variety of catechu, is extracted from various plants, such as *Butea frondosa*, *cocolaba uvifera*, *Pterocarpus marsupium*, and other plants.

Its composition is:

Tannin, ...	45.3
Extractive matter, ...	39.5
Gum, ...	8.5
Impurities, ...	6.7 = 100.

Catechu is adulterated by numerous vegetable extracts, and with sand, clay, and ochre. The last-named adulterations can be easily detected by dissolving some of the catechu in

water, and these impurities will settle, as good catechu is all soluble in water, and gives a clear solution of a yellowish-brown color, which the acids will brighten and alkalies darken, and the shade will deepen by standing. Some catechus have been found to contain from eight to ten per cent. of clay and sand mixed with them.

The tannin in catechu is not so easily converted by exposure to the atmosphere into gallic acid, as nutgalls are, but it is subject to oxidation.

In coloring cotton-yarn with catechu, the threads will adhere to each other when dry; but by giving the solution a small quantity of sulphate of copper, this gummy substance is precipitated, because the copper salt will oxidize a portion of the catechu. Although this gummy substance is insoluble in water, yet it is soluble in the deoxidized catechu; therefore the whole must be held in solution in the bath.

The yarn now being passed through this solution, will come out of a yellowish-brown color, and does not stick together, which is not the case if the copper salt had not been used. Now pass the yarn through a solution of chrome, and we obtain a deep, rich brown. Whether the bichromate of potash ($K_2Cr_2O_7$) acts as a base on any part of the catechu, or the yarn, we are not prepared to say; but on burning cotton-yarn dyed brown by this process, you will obtain in the ashes of the cotton the oxides of both the copper and chrome, proving that both the chrome and copper used must have an active part in the formation of the color; and it also proves that the dye is something more than the mere oxidation of catechu. When catechu is oxidized, there is a formation of an acid nearly like that of gallic acid; but this acid is only formed when a solution of catechu is treated with an alkaline substance. This drug is now used in almost all the compound colors on raw cotton and cotton-yarn, such as blacks, browns, drabs, fawns, and greens, and its permanency is the reason why it is esteemed so highly in the coloring of raw cotton at the present time. Mr. Cooper made an analysis

of a sample of catechu, giving a wider range of the matters contained in it, and which will serve to give a better idea of the various kinds of this substance, for, from the different methods of preparation, probably there are no two samples that will give the same proportions. The following is the result of his analysis:

Tannin,	62.8
Extractive or coloring matter,	8.2
Resinous matter,	2.0
Gummy matter,	8.5
Insoluble matter,	4.4
Water,	12.3
	98.2

COCHINEAL.

This coloring material is a small insect, called *Coccus cacti*, found on small species of the cactus plant, but more especially upon the napal plant and *Cactus opuntia*. This insect, as well as the plant on which it feeds, is cultivated in Mexico, Java, Algeria, Central America, &c. It is a native of Cuba, St. Domingo, and other West India islands.

At one time the German chemists stated that the plant upon which the insects feed was the source from which the coloring-matter was obtained; but experiments made with that object in view, go to show that the animal economy plays a very prominent part in the formation of the coloring-matter.

The male insect is of no value as a coloring material, and he is winged, while the female is wingless. The female insects are collected twice a year, immediately after they have been fecundated and have laid eggs for the reproduction of young. They are then collected by shaking them

from the plant on cotton sheets, and are killed either by steam or by the heat of an oven, but usually by the last method. Two varieties are known in the trade, the black and the silver-colored cochineal. Another kind is called the wild cochineal, on account of their being collected from plants growing wild or in a state of nature, but this kind is inferior to the other varieties. Cochineal appears as small, deep brown-red grains, on the flattened side of which the structure of the insect is somewhat discernible. Sometimes the dried insect is covered with a white dust (called powdered talc), which is caused by the dealers dusting the cochineal with either talc or chalk, in order to deceive the purchaser; this is only done with the poorer kinds of cochineal. There have been many investigations upon cochineal, but the results have not been very satisfactory. These are some of the instances. Cochineal contains: —

1. Carmine, which may be termed the coloring-matter.
2. A peculiar animal matter.
3. A fatty matter, composed of stearine, bleine, and volatile fatty acids.
4. Saline matters, as phosphate of lime, carbonate of lime, chloride of potassium, phosphate of potash, a combination of potash with organic acids.

Dr. John gives as his analysis the following results: —

Red coloring-matter, . . .	50.0
Gelatine, ...	10.5
Wax, ...	10.0
Debris of skin, &c., . . .	14.0
Gummy matter, ...	13.0
Phosphate of lime, of potash, and iron, chloride of potassium, . .	2.5

Its constituents are, according to Dr. Ure's "Table of organic analysis": —

Carbon,	50.75
Hydrogen,	5.81
Oxygen,	36.53
Azote,	6.91 = 100

Cochineal contains a peculiar kind of acid, called carminic acid ($C_{17}H_{18}O_{10}+3\ H_2O$). Diluted sulphuric acid will split up this acid into carmine-red (carmine), and into dextrose, and as this acid contains carmine and dextrose, which is present in the insect, the re-action is thus expressed: —

$$\underset{\text{Carminic acid.}}{C_{17}H_{18}O_{10}}+3\ H_2O = \underset{\text{Carmine-red.}}{C_{11}H_{12}O_7}+\underset{\text{Dextrose.}}{C_6H_{12}O_6}$$

There is another adulteration of cochineal besides the dusting of it with talc and chalk, which consists in extracting some of the coloring-matter from it by boiling in water and then soaking it again in a concentrated solution of Brazil-wood or logwood; then it is dried and dusted again with talc, as before. This can be detected by boiling a small quantity of the suspected cochineal, then adding a little lime-water to the solution, which will precipitate all the coloring-matter of cochineal and will leave the solution clear, but if Brazil-wood or logwood is present in it the solution will be a purplish red after the lime-water is added.

"In making choice of cochineal, see that each grain exhibits a bright, free, clear, bold, large appearance; that the whole mass is free from dust or small abraded parts of the insect or other matters foreign to its nature, and that a quantity of it, when poised in the hand, has a certain weight, feel, or specific gravity, which any person that is much accustomed to, can distinguish with the greatest nicety."

"Cochineal contains 50 per cent. of a pure crytallizable coloring-principle, which is easily given out to boiling water, forming a well saturated solution of a deep crimson or claret

color." A strong solution of it exhibits the following results with re-agents: —

Copperas throws down a plum-colored precipitate.

Blue vitriol — a red precipitate; a portion of the colors remain in the solution.

Nitrate of copper — a brighter color of the same character, the solution not so much colored.

Nitrate of mercury — a brown chocolate sediment, and solution lilac-colored.

Nitrate of lead — a heavy purple precipitate, and solution nearly colorless.

Nitrate and sulphate of zinc — results very similar to the lead.

Nitrate of silver — a dull, bluish-black precipitate.

Nitrate of lime — a scanty precipitate, the solution blued up to a violet or deep lilac.

Sulphate of magnesia — no precipitate, the color of the solution unaffected.

Oxalic acid turns the solution to an orange color and a scanty precipitate of an aurora color.

Citric acid — similar effects, only of a redder hue.

Tartar brightens up the solution, causing it to assume a fine scarlet color, and after some time a light-red precipitate falls.

Super-oxalate of potash produces more decided effects of the same character as tartar.

"Alum gives the solution a fine crimson appearance, and a moderate precipitate of the same color takes place, the solution still retaining considerable coloring-matter, which a solution of nitro-muriate of tin will precipitate to a more decided scarlet, leaving the residuary solution of a pale fawn color."

"All the alkalies cause the claret-colored solution of cochineal to pass to a deep violet, with scarcely any, or very small precipitation, and even several neutral alkaline salts, such as

muriate of soda, &c. (common salt), have similar but feebler effects. Other acids, not named above, act in a similar manner, with some variations, differing but little in their mean results from oxalic and citric acids."

From these results and observations, we may infer—

"First. That tartar is useful, by causing cochineal to give out its coloring-principle more completely to water, and that it turns its natural color more towards scarlet, and the larger the amount of tartar, the more this color tends towards aurora."

"Second. Therefore a definite quantity of this acidulous salt is necessary in dyeing scarlet and its different shades, not only to give the peculiar tone of scarlet to the color, but also to create a greater quantity of it, by aiding the cochineal to produce a more abundant precipitate of color than it otherwise would; but, again, the quantity of tartar must not exceed a certain proportion, because, as the roseate hue of the scarlet is more and more changed towards aurora, the greater the excess of tartar over the just proportion."

"Third. As our scarlet color may be considered a compound of a pure red or carmine, and a small proportion of yellow, and although we could communicate the necessary yellow shade to it by working the cochineal towards the aurora, by using an excess of tartar, yet we economize the consumption of that expensive article, and obtain a more desirable color, by producing the yellow part from a less expensive dyestuff, such as flavine, fustic, &c."

"Fourth. Tartar is also necessary in dyeing any of the shades of crimson, from a pink upwards; but in a much less proportion than for the scarlet shades, because all we want of it in this case is merely to spring the cochineal, and still preserve, as much as possible, the bright crimson tint natural to it. The proportional quantity of tartar to the cochineal, in these two cases, is about, for the scarlet, five of tartar to five

of cochineal; and for the crimson, three of tartar to five of cochineal (these parts by weight)."

"Fifth. That solutions of tin are the only proper mordants or base for the scarlet shades, of which solutions, the nitro-muriate is the best; and that alum, with an equal weight of a well saturated solution of nitro-muriate of tin, is the best mordant for crimson shades."

"Sixth. That none of the metallic salts used as mordants with cochineal, produce any better colors than can be obtained from less expensive materials; so they are of no advantage in the application of cochineal as a dye."

"Seventh. And that all alkalies, alkaline earths, and even some neutral alkaline salts, blue up the cochineal colors, making the scarlet approach the crimson, and the crimson pass to the purple shade. The brilliant colors given by this substance are remarkably sensitive to alkaline proximity, for they will indicate by their change of shade, so small a quantity of alkaline presence, as almost to warrant their employment as *tests* of alkalinity. These alterants are, therefore, employed for the heightening, rosing, or bluing of pinks, roses, crimsons, &c., for which purpose ammonia is generally used, as producing the brightest and most desirable effects."

"Eighth. That all acids, and even acidulous salts, cause the colors from cochineal to pass from the crimson to the aurora or orange shade, in proportion to the quantity of real acid strength acting upon them; or in proportion to the power of the particular acid to communicate to, or abstract oxygen from, the cochineal color."

"The oxalic, nitric, and muriatic acids in excess, change the color of scarlet to a deep yellow, which can never be restored to scarlet again, by any known means; notwithstanding this, the cochineal color bears a great acid power before it is much injured."

Cochineal yields rose-colored crystals, by treating it with alcohol and nitric ether. The crystallization of cochineal was

discovered by Pelletier and Caventon, and named by them *carminium*, and an account of it was first published by Dr. Ure in his notes to Berthollett's Elements of Dyeing, some fifty years ago. The true scarlet color cannot be produced by any other known means, than by cochineal and solution of tin.

CARMINE.

Carmine is made by boiling out the color from the cochineal, then filtering the solution; to this filtered solution alum is added, after which it is left to settle. Another method is to boil the ground cochineal in a solution of carbonate of soda ($NaCO_3$); the white of eggs is then added to the solution in order to clarify it, and after this the solution is precipitated with an acid; then washed. The washed precipitate is then dried at 30°.

When carmine is prepared in this manner, it is finer and better than when otherwise prepared, but the common carmine—carmine lac and round lac—is made by treating an aluminous solution of cochineal with soda-ash, and the greater amount of alum contained in carmine thus made, the coarser will be the quality.

Carmine is extensively prepared in France, and is made and largely used for coloring artificial flowers, for making red inks and paints, and it is the substance that lines the pink saucers for beautifying the cheeks of ladies. In making carmine, it is found that a larger amount can be produced from the same quantity of cochineal when a wood fire is employed to boil the solutions, than when coal is used, and why this is so is not yet fully understood. There are many other points which go to show how delicate an operation it is to make good carmine. Light has a great effect in producing good carmine. In making carmine, the residue which is left from the cochineal, is boiled in water for some time; then to this solution they add

a solution of muriate of tin and alum, which precipitates a colored lake. This beautiful lake is termed carmine-lake.

Carmine is affected by the following re-agents thus: —

Tannin will give no precipitate.

Ammonia, soda, and potash change it to a crimson violet.

Strontia and baryta produce the same effect.

Lime gives a crimson-violet precipitate.

Most of the acids change its color from a bright to a yellowish red.

Boracic acid does not change the color, but rather reddens it.

Chlorine turns the color yellow.

The salts of copper change it to a violet, but leave no precipitate.

The salts of iron turn it brown, but leave no precipitate.

The salts of lead change it to a violet, but leave no precipitate.

Peroxide of tin changes it to a crimson violet.

Protoxide of tin changes it to a yellowish red.

Alumina combines with it, and precipitates it as a beautiful red; but if boiled, it passes to a violet red.

FUSTIC.

This dyestuff is manufactured from the dyer's mulberry-tree, botanically termed *Morus tinctoria*, or *Maclura aurantiaca*. It is imported from Cuba, St. Domingo, and Hayti, that from Cuba being the best. It is found growing spontaneously in the Brazils. It is uncertain when it was first introduced as a dye-drug, but mention is made of it as early as 1692. This wood is the color of sulphur, with orange-colored veins, and, in some parts, yellow-red color. This is due to a colorless and crystallized body termed morine ($C_{12}H_8O_5$) present, in combination with lime, and also to a very peculiar kind of tannic acid, termed maclurine (having

for its formula, $C_{13}H_{10}O_6$), which we find deposited in the wood in large quantities, which becomes yellow by being exposed to the air, and in contact with alkalies. This wood has been long employed for coloring yellows and greens; but, for these colors, it is almost superseded by flavine and quercitron-bark, especially on cotton-yarns, light cotton fabrics, such as muslins, &c.

A solution of fustic should be used immediately after being boiled from the wood, as, after it begins to cool, the coloring-matter begins to precipitate; and if allowed to stand for twelve hours, it is unfit for use, as the morine, or coloring-principle, will crystallize, and settle at the bottom of the dye-tub, and will not completely dissolve again in its own solution, and loses its coloring properties, which every practical dyer must have observed. Fustic requires more boiling than logwood or hypernic, but not so much as camwood, barwood, or sanders. Fustic is almost an indispensable material in woolen-dyeing, as it is used in almost all those colors where a yellow enters into their composition; and it being cheap, and giving durable colors either with or without mordants, we cannot very well find a substitute for it. Its greatest consumption is in making the compound colors, such as browns, olives, drabs, greens, &c.

A decoction of fustic will give, with the following re-agents, these results: —

Alkalies give an orange color, with a green tint.

Muriate of tin gives a rich yellow.

Nitro-muriate of tin (yellow spirits) gives a reddish yellow.

Potash sulphate of alumina (alum) gives a canary-yellow.

The proto and per salts of iron (copperas and iron liquor) give a greenish-olive tint, which darkens by standing.

Cupric sulphate (blue vitriol) gives a green olive.

Nitric acid gives a red precipitate.

Sulphuric acid gives a red precipitate after standing for a short time.

Recipe for Yellow with Fustic.

375 lbs. wool (coarse) in the grease, or 187 lbs. clean:
15 lbs. Alum,
7 lbs. Red Tartar,
5 lbs. Muriate of Tin,
70 lbs. Chip Fustic.

Boil out the fustic for one and a half hours. Then take out the bags containing the fustic, and add to the solution the alum, tartar, and tin-liquor. Stir up the whole. Then enter the wool; pole up well, and boil for one hour. It is immaterial whether you wash off the wool from the color or not. This recipe gives a very permanent color, and is used for listings and mixtures. A deeper color is produced as follows: —

200 lbs. coarse wool in the grease, or 125 lbs. clean:
60 lbs. Chip Fustic,
6 lbs. Red Tartar,
12 lbs. Alum,
2 quarts Muriate of Tin.

Proceed as above in all particulars.

YOUNG FUSTIC, OR FRENCH FUSTET.

This is a green-yellow wood, exhibiting brown-colored stripes through it, and is obtained from a European shrub. Its botanical name is *Rhus cotinus*, a plant growing in the southern parts of Europe, principally in Italy and Southern France, and was long used in France, and called fustet, for giving a yellow dye. The prefix "young" was given to it on account of the smallness of its branches in comparison to the yellow wood, designated as old fustic. The fustet contains a peculiar coloring-matter, termed *fustine*, and, by some chemists, *fusteric*, and a large quantity of tannic acid. It also appears that it contains a coloring-matter not unlike quercitron-bark.

This wood gives the following results with re-agents: —

Acetate of lead gives a yellowish-white.

Iron salts (copperas) give an olive-green color.

Nitro-muriate, and muriate of tin, give an orange-yellow precipitate.

Alkaline solutions change the color of the solution to red.

The coloring-matter of young fustic has a very strong attraction for oxygen, which affects its use as a dye when durability is required. I have not seen any of it in this country for the last twenty-five years, and do not think it is in the market. It was used at that time as an assistant to strike some particular shade or tint. It was used, along with quercitron-bark, to give the sulphur, or greenish tint, to sulphur yellows. I never knew it to be used in cotton-dyeing.

FLAVINE.

This is a coloring-matter that has not been used in the woolen dye-house until within the last twenty years. It is made from quercitron-bark, which is the inner bark of the black oak, called *Quercus nigra*, and, by some botanists, *Quercus tinctoria.* The manner of manufacturing flavine is first to grind the quercitron-bark into a very fine powder; it is then called quercitrine ($C_{33}H_{30}O_{17}$); the color of it is a bright-yellow, and it contains tannic acid, with the addition of a yellow pigment. This powdered bark then goes through a process of exhaustion with soda, and afterwards is precipitated by diluted acids, or is made a garancine by precipitating it with oil of vitriol; it is then dried and is ready for the market or the dyer's use. Flavine is the chief yellow dye, used along with picric acid, for yellows at the present time;

that is, where fastness is not required. Picric acid has for its formula —

$$C_{12}\left\{\begin{matrix} H_2 \\ 3\ NO_4 \end{matrix}\right\} O,HO.$$

Flavine is now used in dye-houses in place of quercitron-bark, it being far superior to the bark both in the amount of the coloring-matter it contains and the clearness of the yellow it imparts to the wool, — one pound of flavine being equal to ten pounds of the bark and to thirty pounds of fustic. In using flavine it has to be made into a paste before adding it to the dye-tub, and after it is thus prepared it should be used soon, as, if allowed to stand overnight, it will precipitate and deposit a brownish-yellow mass in consequence of its not being all completely soluble in water; even if boiled in distilled water and allowed to stand for twenty-four hours it will form the same deposits. The proper mordants for this drug are alum, tartar, and nitro-muriate of tin. The acids lighten the color of a solution of flavine and the alkalies deepen it, causing it to assume more of a red color.

Potash sulphate of alumina (alum) gives a very rich yellow.

Nitro-muriate of tin gives a yellow-orange.

Muriate of tin gives a sulphur-colored yellow.

Proto-sulphate of iron (copperas) gives a deep greenish-black.

These are the re-actions given on a solution of flavine.

TURMERIC.

This coloring substance is manufactured from the root of the *Curcuma langa*, a plant that grows in the Indies and on the Island of Java. The root is found in egg-shaped tubers and in flattened lumps, and is of a dirty yellow color. Its pure coloring matter is called curcumine ($C_8H_{10}O_2$). It is

ground into a powder and resembles ginger, the solutions of it have a peculiar smell, and it has a bitter taste. The color given by it is very fugitive, there being no proper mordant for it that will make it a permanent color. It is used mostly for giving a peculiar tint to greens and browns on cotton and silk, also on wool, but not on wool when colors are to be permanent. It is used for test-paper to detect alkalies and boracic acid, by which the paper will be turned to a red-brown.

MADDER.

This plant or shrub is termed *Rubia tinctorium* and is cultivated in France, Holland, and the Levant, besides in the southern, western, and central parts of Europe; the East Indies also furnish a large amount of it. The coloring-matter obtained from this shrub rivals indigo as a vegetable-dye, both in beauty and brilliancy of the colors given by it, as well as by the numerous shades that can be dyed from it.

Madder is a perennial plant, and there are quite a variety of *Rubia tinctorium* plants, such as *R. peregrina*,—that cultivated in Smyrna and Cyprus, being the best kind; the *R. mungista* of Japan is found in a wild state.

According to researches or experiments and analyses made, the dye imported from India under the name of munjeet is not the root of the *Rubia tinctorium*, but the reedy stem of a species of the *rubia* plant, and, for dyeing purposes, is very inferior to the root of the plant. This plant is a native of Caucasus; the root generally is knotty or gnarled and a little thicker than a quill; externally its bark is of a brownish color; internally it is of a yellow-red color; it is first dried, after being dug, and then ground and put into strong oaken casks, in which form it is received by the dyer. Madder should be kept in a dry place, as it easily absorbs moisture, which is an injury to it; when kept dry it will improve by age; its age

is ascertained by the appearance of the head of the cask; if it is two or more years old the head will be swelled out by the swelling, or, as it is termed, the madder has grown; but dealers have learned this criterion by which dyers judge of the age of madder; so to make new madder appear older than it really is, they will moisten it at the bottom and top of the cask, which causes it to swell and so cause the heads of the cash to bulge up. The quality of the madder is ascertained by its taste and smell; the good will have a heavy, sweet smell, with an earthy flavor; its taste is a bitter-sweet; when exposed to moisture, its color will pass from the orange-yellow tint to a deep red. What is known as mull-madder is the refuse and dust from the floor of the grinding-room; therefore it is of an inferior quality, and we might say, of the worst quality. Mull-madder is not used in this country at the present time; the principal use made of it now is in the production of *garanceux*, which we will speak of hereafter.

Madder is sometimes adulterated with brick-dust, red or yellow ochres, sand, clay, sawdust from mahogany, logwood, and sandal-wood. The mineral impurities, such as brick-dust, ochres, sand and clay, may be detected by putting some of the madder in a glass jar and pouring boiling water upon it; the madder will float and the above impurities will sink to the bottom. To detect the vegetable adulterations, Mr. Pernod, of Avignon, proposes the following tests: "A sheet of white paper is immersed in a weak solution of bichloride of tin (nitro-muriate of tin—formula, $SnCl_2 + NH_4Cl$) for a few minutes, then place the paper upon glass or porcelain, and sift the madder upon the paper; in half an hour afterwards the paper will show crimson-red spots if the madder contains any of the red woods, purple spots if it contains logwood, and a yellow coloration if it contains any fustic. If the madder is free from the above adulterations the paper will be colored a light yellow."

The first investigations made upon the chemical properties of madder, led to the discovery of two distinct coloring-mat-

ters, one yellow, the other red; the yellow was then called *xanthine* (now called *ruberythrinic* acid), and the red, *purpurine.* Recent discoveries have been made which disclose five distinct coloring-matters in madder, yet there are but two distinct pigments in the fresh roots, being the two above-named. In addition to these two coloring pigments, it was discovered that madder contained about eight per cent. of sugar.

According to Dr. Rochlerder, the former of these (*xanthin*) is converted, under the influence of a peculiar nitrogenous substance, present in the madder-root, into alizarine,—the essential coloring-matter of madder,—and into sugar. The formula is,—

$$\underset{\text{Ruberythrinic acid.}}{C_{20}H_{22}O_{11}} = \underset{\text{Alizarine.}}{C_{14}H_8O_4} + \underset{\text{Sugar.}}{C_6H_{12}O_6} + H_2O.$$

Other investigations have proved that there are five different coloring-matters in madder, which are thus named: madder-purple, madder-red, madder-brown, madder-orange, and madder-yellow. Besides these five coloring-matters in madder, it has been found by the German chemists that madder contains not only these five coloring properties, but two acid substances, which they name the *madderic* and *rubiacic* acids. These acids, however, contain no known coloring properties, and I have only mentioned them to show the knowledge that chemists are in possession of, and what substances are contained in madder, as obtained by their laborious investigations. These investigations of madder were so important, that the *Société Industrielle de Mulhouse* for a number of years offered two thousand francs for the best analytical investigation of the substances contained in madder. The above-named coloring-principles of madder, taken separately or by themselves, do not form a good dyeing material, but they do constitute the elements which will together produce the richest and the most permanent red dyes that the dyer now possesses. Practically, it is only necessary to consider

madder as containing but two coloring substances or properties, as in former days supposed, one of which was the dun or yellow, and was considered the impure or earthy part of the madder; this impurity is what the dyer endeavors to get rid of. The other coloring substance was called the red coloring-matter. Madder can be made to produce a variety of shades by the skilful dyer, by the different proportions and changes of the mordants he may use; and the colors obtained are more permanent than those produced by any other vegetable substance known as a dye, not excepting colors obtained from indigo or cochineal.

The varieties of madder in the market are known and called by the name of the country in which they are raised or grown; also by the looks or appearance caused by the different processes of their manufacture, previous to their being received by the dyer. The Dutch madder, so called, is very coarsely ground, which enables the purchaser to judge of the nature and quality of the root from which it was made. This madder, you will find, has a sort of a greasy feeling, and a very strong and rather disagreeable smell or odor, and its color will vary from a brown to an orange-red, the brown being inferior to the orange-red. It will become more damp when exposed to the air than any of the other varieties of madder, this being taken advantage of in judging of its quality; for if good, its color will pass from the brownish-orange tint to a deep red color. This madder is said to be *uncropped* or *cropped* madder, the only difference being in it, that one is separated from the bark of the root, while the other is composed of both bark and body of the root. This madder is in its best state or condition when it is two or three years old, but it can be older without its coloring properties being impaired. Yet I think, at the above age, it is as good as it ever will be for producing brilliant colors.

The Alsace madder is very similar to the Dutch, and although the *cropping* is generally performed upon it, it is not designated by being *cropped* and *uncropped*. It will readily

absorb moisture from the air, and become of a reddish-brown color. This madder is inferior to the Dutch madder, its odor is more penetrating and its taste less *sweet;* yet it has an equal amount of bitter, and its color is more yellow and will pass into brown, having a lesser orange tint.

A little experience will soon enable the dyer to distinguish or judge the one sort from the other, by comparison. The Avignon madder, at one time, was considered the best. There are a number of varieties of this madder, but all the difference that I could ever ascertain in them was in their different modes of preparation, and also the soil in which the plant grew. This madder will feel drier to the touch, and will not absorb moisture so readily as other madders; but if exposed to a humid atmosphere it will undergo a great change. Its smell is very agreeable; its taste is a mixture of the bitter and sweet; and its color will vary from the pink to a deep red; or we might say, a reddish brown. The commercial marks upon the casks, to designate the quality, are, —

S. F., for superfine.
S. F. F., for fine superfine.
E. S. F. F., for extra fine, fine;

but I have found these marks placed upon casks of an inferior madder, so it does not do to judge entirely by the marks. I have given, in the description of the different madders, criterions whereby a dyer may judge of the quality of the madders which he may have to use, without having to rely upon the marks placed upon the casks. The above varieties will of themselves vary greatly, according to the nature of the plant, and also in the manner in which the roots are dried or otherwise prepared. This kind of madder can be used when freshly ground, but is better to be kept a year or more before using it. It does not cake or become hard like the other madders, but if it is too old it becomes loose or powdery, and undergoes a kind of decomposition.

As I have remarked in this article, the Levant, or those

madders brought from Smyrna and Cyprus, were the best kinds. I consider them so for this reason: the roots are not taken out of the ground until they are four or five years old, while the other madder-roots are taken up in every two or three years, and do not become matured in that space of time, neither do they contain so large an amount of coloring-matter as those roots of a longer growth. Madder can become so old that it will not produce good reds upon cotton-yarn or cloth, and yet not be unfit for coloring wool or woolen fabrics; yet I think that madder, after it is three years old, will not produce so good a result, either used alone or in combination with coloring-matters, as when it is but twelve months since it was ground.

The Different Products of Madder.

There are two coloring substances obtained from madder that are largely employed in calico-printing at the present time; viz., *garancine* and *colorine*. Garancine is a chocolate-colored powder, having neither taste or smell, but from the different modes of extracting it from the madder, and also from the different qualities of madder used in its preparation, it varies greatly in quality, for which reasons it has been repeatedly used and as often abandoned as a dye on woolen fabrics; but latterly, means have been devised by which the quality of garancine can be tested, these tests having been very favorable to its more constant use as a dyeing material for cotton and calico-printing. Garancine was first discovered and the process of obtaining it described, by Robiquet and Colin, so long ago as 1826; but this was long before it was generally introduced to the trade. Their method of preparing it was, to take one part of madder to six parts of cold water, and allow the mixture to soak for twenty-four hours; then it was placed upon a filter; after draining thoroughly it was pressed; then it was again steeped in cold water, again pressed, and so on for the third time. After these processes are completed there is half as much oil of vitriol (by weight) as

there was of madder used; the vitriol is diluted with double the amount of water, the temperature being raised to 100° Fahr.; this is then added to the pressed madder as soon as possible, then stirred up rapidly; heat is then employed and the temperature raised to 212° Fahr., and kept at that heat for one hour; it is then washed thoroughly with water and the whole thrown upon a filter; water is then poured over the residue left upon the filter until there is no taste of the acid left; it is then taken and submitted to hydraulic pressure, for the purpose of getting rid of all the water possible, after which it is dried and ground to a very fine powder; in this condition it is received by the dyer, and is called *garancine.* During the last eight or ten years the consumption of this article has greatly increased. Garancine is also obtained from the waste madder of the dye-house, that is, from madder that has been once used; and the process was patented in 1842 or 1843. The method, or operation of producing it, is so complicated and lengthy that few dyers would attempt the manufacturing of it, for which reason I will not give a description of the process, but will state the action of garancine with re-agents and water, so far as I have tried them:—

Water, with ammonia, gives a beautiful red color.

Water, with carbonate of soda, gives a bright reddish color.

Water and alum give a chrome-red color.

Water (boiling) and alum give a dark red color.

Ammonia gives a red; in a few hours it is so deep that it is not transparent.

Water, with muriatic acid, gives a greenish-yellow tint.

Water, with sulphuric acid, gives the same after a few hours.

Water, with nitric acid, gives a still darker tint, but passes to a brownish blue.

The value of garancine (as a dye) to madder, is one to four; that is, one pound of garancine will produce as good a red as four pounds of madder.

Flowers of Madder. This preparation is obtained on a large scale, from madder, by soaking it in water, which

causes the sugar contained in it to ferment. After it has soaked or fermented for forty-eight hours, the residue is then thoroughly washed, first, in lukewarm water, then in cold; it is subjected to hydraulic pressure to remove the water; it is then dried at a gentle heat, then ground up again, then it is used in the same way as the ground madder for coloring purposes.

The flowers of madder, when dyeing with them, do not require so hot a bath as madder itself does. When the flowers of madder are boiled in wood spirits (methylic alcohol) a very copious yellow precipitate is formed, from which, after being washed in cold water and dried, you obtain a substance called azale, which has been tried as a dyeing material in France, but no good results have yet been obtained from it. Probably this substance is the crude alizarine met with in the market, under the name of pincoffine, it being first discovered and prepared by Mr. Pincoffs, of Manchester, England.

Colorine. The substance met with in the market under the name of *colorine* is the alcoholic extract of garancine dried, and is composed of alizarine, purpurine, fatty matters, and other substances soluble in alcohol present in garancine. E. Kapp, some years since, exhausted madder with an aqueous solution of *sulphurous acid*, and so obtained the pigments of madder in a pure state (which he used for technical purposes). These preparations are now extensively used, and are distinguished by the names of green alizarine, and that obtained from the Alsace madder amounts to about four per cent., containing, with the alizarine, a green resinous material called yellow alizarine; the former substance (green alizarine) is without the resinous material, this having been eliminated by suitable solvents, as purpurine and flowers of madder. Madder of a good quality yields, on a large scale,—

Purpurine, . . .	1.15 per cent.
Green alizarine, . .	2.50 " "
Yellow " . .	0.32 " "
Flowers of madder .	39.00 " "

Alizarine. The researches and experiments of Graebe and Liebermann prove that alizarine is a derivative from anthracen ($C_{14}H_{10}$), the formula of alizarine being ($C_{14}H_8O_4$). Alizarine is yellow but will become red under the action of alkalies and alkaline earths.

Anthracen, from which artificial alizarine is obtained, is present in coal-tar to the amount of .75 or 1.0 per cent., and was discovered in 1830 by J. Dumas. In 1869, Graebe and Liebermann first commenced employing it for the production of anthracen red, or artificial alizarine. According to the original method of preparing alizarine the anthrachinan ($C_{14}H_8O_2$) obtained from anthracen by the action of oxidizing agents, such as nitric acid, was first converted into bibromide of anthrachinan ($C_{14}H_6Br_2O_2$) by treating anthrachinan with bromide, and this bromated compound was further treated either with caustic potash or caustic soda at a temperature of 180°, or 200° Fahr., the bibromide of anthrachinan being converted into alizarine potash (or alizarine sodium, if caustic soda had been used) from which the alizarine is set free by the addition of muriatic acid. Alizarine is now made or prepared from anthrachinan by heating it to a temperature of 265° Fahr. with fuming or concentrated sulphuric acid; the anthrachinan is by this operation converted into a sulpho-acid; this acid they then neutralize with carbonate of lime ($CaCO_3$); the fluid is decanted from the precipitated gypsum, then carbonate of potash (KCO_3) is added to it in order to precipitate all the lime; this solution is then evaporated to dryness, the resulting saline mass is converted into alizarine potassium ($C_{14}H_6K_2O_2$) by heating it with caustic potash (KOH). From the alizarine potassium thus obtained the alizarine is set free by the aid of hydrochloric acid (muriatic acid). By another method anthracen is employed directly for obtaining alizarine, by first converting it, with oil of vitriol and heat, into anthracen sulpho-acid ($C_{28}H_{18}SH_4O_3$). After being diluted with water, the solution of this acid is next treated with such

oxidizing agents as nitric acid, chromic acid, and lead, and the fluid is next neutralized with carbonate of lime. There is no doubt but anthracen may be converted into alizarine by other means, and it is very likely that from other hydro-carbons, such as benzol, toluol, naphthaline) present in coal-tar, anthracen red may be obtained. Alizarine with alkalies gives a violet solution, and is nearly insoluble in a solution of boiling alum; it is soluble in turpentine, naphtha, and fat oils; chlorine turns it to a yellow brown; sulphuric acid dissolves it but at the same time brightens up the color; muriatic and nitric acids will dissolve it and change the color from red to yellow.

Green alizarine is considered as good as the commercial alizarine, and better than the flowers of madder, and it requires from ten to twelve per cent. less mordant; it should be made into a paste with water before adding it to the bath. The coloring power of alizarine is ninety-five times greater than madder.

Purpurine. This is also a product of madder, and is equal to sixty times its weight of the madder from which it was extracted. It is soluble in ammonia, acetic acid, and water; also in the alkaline carbonates. The alkalies give a red, but will fade by exposure to air; alum gives a pink color. Purpurine is not affected by lime, but alizarine may be precipitated by it. [You will find recipes for coloring with purpurine in another part of this work.] Purpurine does not give good purples on cotton, with iron mordants. In coloring cotton-yarns with madder, or the different products of madder, the mordants used are the acetate of alumina, or red liquor, so called, acetate of iron (iron liquor), acetate of lead, acetate of copper, and the chlorides of tin.

As above stated, purpurine is not affected by lime, but alizarine may be precipitated by it. These two assertions are correct; that is, when we come to take into consideration the nature of the various kinds of madder that these products

might be extracted from; for instance, the madders from Alsace and Holland are grown in argillaceous soils, and have an acid re-action, and will require a certain amount of lime or soda in order to be neutralized. But the Avignon madder, on the other hand, is grown in calcareous soils, and is perfectly neutral, and an excess of lime would be injurious in its results. The same reasons are also applicable to garancine, as it often contains an excess of acid. In this case calcareous water (lime-water) would be beneficial.

Under the head of garancine, I should have mentioned that it requires the same mordant that madder does, and that it will yield up its coloring properties only at a boiling heat, and that the water is but slightly colored before the wool or fabric is entered. A small amount of sumac is very beneficial when coloring reds on cotton-yarn with garancine. The color obtained from garancine is more lively and brilliant than that from madder, and in printing on cotton the color is not so liable to run into the white, for which reason the cloth is more easily cleared than it would be if madder was used.

Purpurine is very soluble in a solution of alum, and the solution will turn to a pink color. Alkalies give a solution of purpurine a red color, but the color will not stand exposure to the air.

In using purpurine for coloring silk, it should be neutralized with either chalk or soda-ash; and for cotton, the yarn must be mordanted in the usual manner for reds, with the addition of a little tannin; and for calico-printing, use three-quarters of an ounce to one quart of water, and twenty-two per cent. of soda-ash. These are boiled up together, then filtered, and thickened with the usual thickening. Wool is mordanted with alum, tartar, and nitro-muriate of tin, or tin crystals. With tin and tartar for a mordant, we get a scarlet nearly as good as a cochineal scarlet. Alum and tartar, with purpurine, give a crimson-red.

A good tin solution for purpurine is made as follows:

30 lbs.	Nitric Acid,
10 lbs.	Water,
5 lbs.	Sal-Ammoniac,
5 lbs.	Feathered Tin.

After the acid has become cold, add the tin gradually. Not to be used until it is four or five days old.

LOGWOOD.

This dyeing material was first discovered by the Spaniards, in 1662 (in Honduras), and was brought to Europe shortly afterwards. They called it *Campechia*, but it is known to botanists by the name of *Hæmatoxylon Campeachianum*. Its nature, and the art of using it as a coloring agent, seem to have been but little understood in Queen Elizabeth's time, as we find an act of parliament prohibiting and abolishing its use in her domain, imposing a penalty of imprisonment and the pillory upon any dyer who should use it. Upwards of a hundred years elapsed before the virtues of this dye-wood were known and acknowledged, and at the present time there is no other wood so universally used, or useful, as logwood; but, like many other valuable dyestuffs, it was used for a long time before the true nature of its coloring-principle was known. Some time near the year 1810, Chevreul made a chemical examination of logwood, and by careful investigations found that it contained a distinct and pure coloring-principle, which he called hematine (not *hemateine*), a name which has since been changed to hæmatoxyline ($C_{16}H_{14}O_6$), so as to avoid any confusion with the name of a similar substance contained in blood. It is commonly called extract of logwood, and is a transparent crystalline substance. By itself it is not a pigment, but is a colorable material, which becomes colored when brought in contact with strong alkalies, and more so

when in contact with ammonia (NH_3) and the oxygen of the air; and a solution of it is nearly colorless (especially in cold water), but will turn at once to a purple-red by the addition of the smallest quantity of ammonia. Chevreul's process for obtaining the extract (hæmatoxyline, or coloring-principle) of logwood is to digest the ground or chipped wood in water, at 120° or 130° Fahr., afterwards filtering the liquor and evaporating to dryness, and that which remains is put into alcohol; this is again filtered, and the clear liquor is evaporated until it becomes thick; to this is added a little water, and evaporated again; it is then left to itself, and the coloring-matter crystallizes. The extract possesses the same properties as the decoction of the wood, and is in comparative strength to good logwood as one is to five; that is, one pound of extract is equal to five pounds of the chips. The action of metallic oxides upon the hæmatoxyline, or hematine, is somewhat similar to their action upon logwood itself, varying considerably with the dissolving menstrua of the oxide, and the particular state of oxidation.

Proto-salts of iron give blue-black precipitates — permanent.

Per-salts of tin give deep wine-colored precipitates, which become brown.

Chloride of tin gives a rich wine-color.

Acetate of copper gives a greenish-black, passing to brown.

Acetate of lead gives a brownish-black precipitate, passing to gray.

Salts of alumina give wine-colored precipitates — permanent.

These are the principal metallic salts used with logwood, and their effects upon it; but the acids in which the oxides are dissolved have a material effect upon the results obtained, the iron being used in a state of sulphate or acetate, and the tin as chloride with free acid, and the copper and lead as acetates.

Erdmann made an improvement upon Chevreul's method of

obtaining hæmatoxyline from the rough wood. After converting a decoction of it into extract, he evaporated the extract to dryness; then pulverized and mixed it with a quantity of pure silicious sand, to prevent the agglutination of the extract. It is then left to stand a few days in five or six times its quantity of ether. This mixture is often shaken or stirred up. The clear solution is then poured off and distilled, until there is but a small, syrupy residue left, and, by this means, most of the ether is saved. This residue is then mixed with a certain amount of water, and allowed to stand a few days, when the hæmatoxyline crystallizes, and may then be dried between tissue or blotting paper. These crystals dissolve easily in hot water, but very slowly in cold water. They are also soluble in alcohol. Dissolve these crystals in distilled water, and the solution will be a beautiful wine-color; but if there is the least trace of lime or iron in the water, the color of the solution will be materially changed. Re-agents have a powerful action upon them. Potash will change the color of the solution to a violet, but it will quickly turn to a purple, and, in a short time, will be almost colorless, on account of the oxygen being absorbed, and the hæmatoxyline is thereby discharged, and the potash is converted into a carbonate from the decomposition of the coloring-matter.

There is an extract of logwood manufactured in France in a crystalline form, the crystals being of a very dark-red color. This is hæmatoxyline with a number of impurities; yet it yields a considerable amount of color.

It must be borne in mind, that Erdmann obtained the crystals by his experiments, and not the extract, as we dyers receive it.

Logwood contains resin and oil, sulphate of lime and alumina, besides the coloring matter. These ingredients vary in the wood from the West Indies, and in that from Campeachy.

A solution of the wood is changed from its natural color, by alkalies, to a purple, and, by acids, to an orange shade.

Almost all the metallic and earthy salts cause abundant precipitates, or lakes, with its solutions, the colors varying from violet to black, but, in all cases, will retain a tinge of the violet hue; and a solution of logwood always throws down a compound color, whose proportions of red and blue vary with the different metals used, and each gives deeper shades, according as it is more or less oxidized. Solutions of tin alone, of all the metallic salts, give it the property of resisting acids, and by a proper course taken with a mordant of tin, a purple can be obtained as durable as indigo-blue. Alum always gives violet-colored shades. Logwood enters into the composition of drabs, slates, violets, plums, dahlias, purples, and all colors that have a tinge of the violet shade in them; also in some very dark browns, &c.; but its principal consumption is in logwood blues and blacks, to which it communicates a softness and glossy lustre, unequalled by any other material.

The mordant which gives it the greatest degree of permanence, is sulphate of iron; that is, in all the colors named above, with the exception of violet, when the solution of tin is the proper mordant.

In Parkes's Chemical Essays, he makes this observation in regard to logwood: "Considerable advantage is derived by woolen-dyers from the use of water in the preparation of their logwood, by spreading it out and sprinkling it with water, and, in that moistened condition, it is thrown into heaps or bins, and allowed to remain as long as possible before using it, and, by that treatment, the wood becomes heated or sprung, and thus undergoes a very remarkable change." But the dyer is now *saved that trouble*, as the *dealers* have become aware of this practice or custom of the dyer, and now *wet it down* themselves with lime and water (thereby making a greater profit, by selling water in place of logwood), and, by this method, they can make the poorest wood, thus *doctored*, appear equally as good as the best. The lime in the water gives the wood a rich red color, a property possessed by all alkalies

and alkaline earths. But this adulteration can be detected by steeping a small quantity of the logwood in a dipper or tumbler, in some distilled water, and then trying the decoction with delicate test-paper. The practice of using lime-water on logwood, by dealers, is why dyers have such poor ground logwood, as all alkaline matters, when in connection with logwood, although at first they give a rich color, will soon pass into a brown, and then to a dark-looking mass, or like dirty sawdust.

I do not know of any simple and accurate method of testing logwood that could be introduced into the dye-house, or, at least, none but what would take too much time and trouble for most dyers.

QUERCITRON-BARK.

This drug is the inside bark of the black oak. It is a native tree of North America, and termed *Quercus nigra* and *Quercus tinctoria* by botanists. It was formerly used for yellows, oranges, and other colors wherein the yellow is predominant; but it is now superseded by flavine. It is very rich in coloring-matter, and water just below the boiling point will extract the color more abundantly than if boiled, and by boiling it you extract the tannin and gallic acid, of which it contains a large amount; these two substances are very injurious to the color, if you wish to have a clear and brilliant shade. A strong solution of this bark, when it is evaporated, will leave a resinous substance of a cinnamon color, which is called quercitrine ($C_{33}H_{30}O_7$). This substance was first extracted from bark by Chevreul and Bolley, and like all other extractive coloring-matters, is considered to be the oxide of a colorless base. The composition of quercitrine is—

Carbon, 16; hydrogen, 8; oxygen, 9; water, 1.

Dr. Bancroft was the first to discover the coloring-properties of this bark, and made it known to the public in 1783.

Some three years afterwards, there was an act of parliament, giving him the exclusive use and application of it for a term of years. One pound of this bark is equal to three pounds of fustic in coloring-principle.

The proper mordant for quercitron is alum, tartar, and murio-sulphate of tin, the whole mordant combined to be about one-half the weight of the bark used, and the bark to be two pounds for every ten pounds of clean wool, for the fullest yellows. The proportions of the two acids that compose the solution of tin, must be made to vary if we wish to obtain yellows of a lemon shade, or yellows of an orange shade; for the orange hue, we must have the greatest proportion of muriatic acid, and for the lemon shade we must have an equal amount of sulphuric and muriatic acids; or, in other words, it must be a sulpho-muriate of tin. (See article on making tin solutions.)

The general rule for determining the inclination of this coloring-matter, either to the lemon or orange cast of shade, is, supposing we are using the murio-sulphate of tin, and we wish to vary from a common yellow, we will have to decrease the amount of alum and tartar (more particular the tartar), and make up the deficiency with muriate of tin, and boil the goods well, if we want the orange cast; and for the lemon cast it will be, to increase the amount of alum and tartar, especially the tartar, and diminish the amount of the tin solution, and make up the deficiency when a decided lemon shade is wanted, by the addition of sulphuric acid, equal in volume to half the solution of tin left out; that is, supposing we are leaving out two pounds of the tin solution, you must add one pound of sulphuric acid to the remaining tin solution.

We can, however, give the lemon shade without so much trouble, by just tinging the dyeing-bath with the least amount of sulphate of indigo (chemic), and the orange cast by cochineal or a little carbonate of soda, but it will be best to give the particular hues by a variation in the mordant.

A solution of this bark will give the following results with these re-agents:—

Alkalies, a deep orange color.

Alum, a canary yellow.

Muriate of tin, a reddish-yellow.

Nitro-muriate of tin, a rich yellow.

Copperas, a greenish-olive tint.

Nitric acid, a red precipitate.

Sulphuric acid, a red precipitate after standing awhile.

Lime, a precipitate of a yellowish-red color.

Muriatic acid, a reddish-yellow precipitate.

By letting a solution of bark stand for twenty-four hours, it will become sour, and will lose a greater part of its coloring-principle, and is therefore unfit for use, as the yellow coloring-matter is deposited, and what remains in solution will give a dull color. For the above reasons, the wool or fabric should be entered as soon as possible after the bag containing the bark is taken out of the dyeing-bath.

LAC-DYE.

This dyeing material we receive from the East Indies, and it is the production of an insect called *Coccus lacca* and *Coccus ficus*. It deposits upon the branches of the tree the cellular substance called stick, from which the lac-dye of the dyer is extracted. This is done by boiling the stick-lac in alkaline water, which dissolves the coloring-matter, along with some of the resinous matters. To this solution is added some alum, which precipitates the whole as an aluminous product or cake; these cakes are then ground to a fine powder, in which condition it is received by the dyer. This dye was first introduced as a dye some sixty years ago, in the state of a lac-lake, which is the coloring matter of the stick-lac, but this lac containing a large amount of resin, as well as other matters of an earthy

or glutinous nature, it was not only very difficult to obtain even a decent-looking color, but the cloth had a harsh, sticky, disagreeable feeling, and dirty appearance, and it was almost impossible to wash the sticky and insoluble matters from the cloth.

At the time of its introduction as a dyeing material, it was a very difficult operation to color with it to what it is at the present day, for the dyers have been gradually making improvements upon their methods of using it, by freeing the coloring-matter from its earthy and resinous matters. Good ground lac should be an impalpable powder, having a smooth and fine feeling like flour, without any gritty or sandy feeling, with few, if any, shining particles intermixed with it. When incorporated with an equal amount of nitro-muriate of tin, it will form a bright, red-colored, stiff and smooth paste. When coloring with lac, the wool or cloth will require more boiling than if you were using cochineal. Lac does not give so clear and beautiful a color as cochineal, but it will withstand the action of acid and alkaline tests much better, and it will retain its peculiar beauty, or resist the light and atmosphere for a greater length of time, than the color given by cochineal. Lac contains about two-thirds as much pure coloring-matter as cochineal, and as the other matters are injurious to, or of no use as a coloring substance, this will in a measure account for the difference there is in the beauty of the reds produced by lac and cochineal.

Dr. Bancroft found that acids would destroy the gummy matter contained in lac, and cause the coloring-principle of it to be made more soluble. There are different methods of using the raw acids with lac; some dyers take thirty-two parts of lac and digest it with ten parts of muriatic acid diluted with the same amount of water (ten parts), and stir it up from time to time, and set it aside for twenty-four hours. Other dyers use three pounds of sulphuric acid (H_2SO_4) to four pounds of lac. After mixing the two together, they then add two quarts of boiling water to it, and

stir it up well, then leave it for twenty-four hours. I think the best way to free lac from the gummy and resinous substance it contains is to digest it in about ten times its weight of water with about one-fourth the weight (of the lac) of sulphuric acid. Or, to be more explicit, we will suppose that it requires sixteen pounds of lac for our purpose; then take one hundred and sixty pounds of water, with four pounds of sulphuric acid added to it; after mixing it well, let it stand for two days; it is then ready for use. In dyeing, you will make no account of the oil of vitriol, but put in just the same amount of tin solution, and other materials that you would use with the lac. The mordants are the same for lac and cochineal, with the exception of the tin solution, which should be the nitro-muriate of tin, called by many yellow spirits. Lac and cochineal are not so much used as formerly, being superseded by the tar, or aniline colors. Most of the scarlets and oranges are now made with purpurine and artificial alizarine.

RED SANDERS, OR SAUNDERS.

This is the wood of the *Pterocarpus santalinus*, and is a native of India, and attains its greatest perfection in the mountainous districts, especially in the mountains of Ceylon and Coromandel. It is a very large tree, with alternate branches, and has petiolate, ternate leaves, each simple leaf being ovate, blunt, somewhat notched at the apex; they are entire, veined, smooth on the upper surface, and hoary underneath. The flowers are yellow-colored. They stand erect, and are somewhat reflexed at the sides, being toothed and waved, spreading with their edges apparently toothed, and the *carina* is oblong, short, and somewhat inflated. The wood comes in roundish, or angular billets. Internally, it has a blood-red color; externally, it is brown, caused by exposure to the weather and atmosphere. It is very compact,

heavy, and fibrous. For the dyer's use it is ground up into a coarse powder. It has little or no smell or taste. It gives a red color to alcohol, ether, and alkaline solutions, but not to water. It is a hard, resinous wood, more so than either camwood or barwood. According to the investigations of some chemists, it is a variety of barwood; at least they assert that its coloring-principles are the same, and that the composition of both are alike; yet they term the pure coloring-matter of sanders, *santalin*, and that of barwood, *brezilin*. These being entirely different substances one from the other, we do not see how their coloring-principles can be alike, and dyers find that there is a great difference between sanders and barwood in the color given by them. Barwood gives a bluer red than sanders. The re-action of alum with sanders gives a violet or purple precipitate, but with barwood, alum gives a very blue-violet precipitate. Neither do the different chromates have the same re-actions upon barwood that they do on sanders, and for these reasons I cannot see how their coloring-principles *can* be the same. If a solution of red sanders is made with alcohol, the sulphate of iron will produce a deep violet precipitate, and a scarlet precipitate with bichloride of mercury ($HgCl_2$). The pure coloring-principle was discovered by Pelletier, and named by him *Santalin*. This substance is of a resinous character, scarcely soluble in cold water, but more soluble in boiling water. It is very soluble in alcohol, ether, acetic acid, and alkaline solutions. Weyermann and Hafferly have found it to possess acid properties. Astringents—such as sumac, galls, &c.—aid the water in extracting the coloring-matter from red sanders. It requires more boiling than any of the other red woods to extract its coloring matter.

Without a mordant, sanders gives a dull, orange-red color to wool, which is quite permanent. Sanders contains more tannin than either barwood or camwood, for which reason it imparts a more harsh feeling to the wool or cloth; but for some particular shades of browns, it is prefer-

able to either camwood or barwood. The re-actions of the metallic salts are the same on sanders as on barwood, with the above-named exceptions.

The composition of sanders is—

Carbon,	16
Oxygen,	32
Hydrogen,	8

Consequently its formula is thus expressed,—$C_{16}O_{32}H_8$.

Red sanders is also known by the name of sandal-wood, sapan-wood. There are two varieties of this wood, the red and yellow. Some chemists describe it as a variety of barwood, and call the pure coloring-matter *santaline*.

According to the researches of H. Weidel in 1869, he found that sanders contained a colorless body which he named *sandal*, and which by oxidation can be converted into santaline, and gave its formula ($C_8H_6O_3$). Pelletier gave its formula ($C_{16}H_8O_{32}$). Alcohol only will extract all its coloring-matter from the wood. In coloring with this wood, it is preferable to use as large a quantity of sumac as is compatible with the shade or color desired.

In saddening with the different metallic salts and alum, the colors will be similar to camwood colors, only that the color will be duller and not so intense, which is owing to its coloring-matter inclining more towards the orange cast than that of barwood or camwood. The principal use of sanders is for coloring browns; it is used for the preparation of colored lakes, for staining furniture polish, for coloring sheepskins red, and as a pigment in tooth-powders.

SUMAC.

This shrub is a native of Syria, called by botanists *Rhus coriaria*; it is cultivated in Spain, Portugal, Italy, and Sicily;

it is known in the market as the Sicily, Malaga, and Verona sumac; the first-named is considered the best kind. The shrub grows to the height of from six to eight feet. The trunk or stem is divided at the bottom into many irregular branches; the bark has a brownish color; the leaves branch out from the stem into six or seven pairs, with an odd one at the terminus. These leaves are placed alternately on the branches, and are surmounted with a blossom of a greenish-white when they are ripe, but of a red-blood color before ripening. This shrub grows wild in North America and Southern Europe. When this shrub is used for dyeing purposes, it is cut down every year; but if for tanning purposes, it is three years old before it will be cut, for which purpose it is nearly as good as oak bark, as it contains from twelve to fifteen per cent. of tannic acid, while oak bark contains from fourteen to sixteen per cent. according to the age of the tree.

The sumac, as I have said, is cut down every year (if for the use of the dyer), then dried and ground into powder. This powder is of a yellow or bluish-green color, when received by the dyer. A boiling solution of sumac has a fragrant and a very agreeable odor, somewhat resembling the smell of boiling tea. Sumac has superseded nutgalls in cotton-dyeing, as the cotton-dyers at the present time use it for bottoming their reds, browns, blacks, purples, and a number of other shades. If used for barwood reds the Verona is the best, as the Sicily sumac does not contain as much tannic acid as the Verona, and these reds being a heavy color, it requires a strong bottom; therefore dyers have to use one-third more of the Sicily than of the Verona sumac for barwood reds.

Sumac solutions, like those of nutgalls, should be used as soon as possible after being boiled, as they very soon commence to ferment, which decomposes the coloring-matters, the tannic acid contained in the galls and sumac being converted into secondary products, owing to a spontaneous fermentation. We will easily ascertain this, by a simple experiment: boil up a given quantity of sumac and let it

stand a few days; then boil up the same amount for the same length of time; now heat up the solution that has laid by these few days, to the same heat of the last boiled sumac; take for each solution the same weight of cotton-yarn, and immerse them in the different solutions for the same length of time; take them out, and you will find that the effects produced will be very different, the one being a clear, light fawn-drab, the other a dirty, grayish yellow, which will prove, more than any written description can, how important it is to attend to such small matters in themselves, but of the utmost importance if we wish to obtain good and correct results.

A strong solution of sumac gives very nearly the same results as a solution of nutgalls, the greatest difference between the two being the quantity of tannic and gallic acid that they contain. This difference in the two varies the effects, so we may, in most cases, substitute a certain quantity of sumac for a part of the nutgalls; yet, in no case, can it be supposed that sumac, in any quantity, produces the same results as nutgalls when applied to wool or woolen fabrics, but for cotton-dyeing the sumac is by far superior to nutgalls. The metallic salts have nearly the same re-actions with sumac as with nutgalls.

NAMES OF SALTS USED.	COLOR OF PRECIPITATES.
Alum gives	a fawn or brownish-yellow precipitate.
Nitro-muriate of tin gives . .	a fawn or brownish-yellow precipitate.
Blue vitriol gives . . .	a yellow-drab precipitate.
Copperas gives	a lead-colored precipitate, verging on black.
Nitrate of iron gives . . .	a decided blue-black.
Nitrate of copper gives . .	a grass green.

Sumac is largely used in Southern Europe, where it grows wild, for tanning purposes, being more particularly used for preparing sheep and goatskins.

NUTGALLS.

Nutgalls are the excrescences that grow upon certain species of the oak, *Quercus infectoria*, caused by the puncture of the *cynip or gall-wasp* for the purpose of depositing its eggs. After the wasp punctures the twigs and leaves, it deposits the eggs and the juice collects around the egg; this juice hardens and forms the nutgall. The galls are best when they are picked before the young insect has become fully grown, as then the gall contains the largest amount of tannic acid.

We have in the market four kinds of nutgalls; the first three are known as the black, green, and white galls. The black and green varieties are those that have been gathered before the insect had become fully developed in the nut, and therefore do not show the outward cavity or opening; but if you break the nut, you will find in the centre a small cavity which is surrounded by a light-brown substance, which contains the larvæ of the insect. The white galls, so called, are gathered after the insect has perforated the nut and escaped. This variety is more spongy, its color is a red-brown, or sometimes a yellow-brown. The above varieties are known as the Aleppo galls, Smyrna galls, and the East Indian galls. Aleppo galls are the best, but we must reckon under the same name those that come from Mosul in Natalia. The Mosul galls are better than the white and green galls, on account of being heavier and larger; the distinguishing character between the Smyrna and Mosul galls is that the darker kind of the Mosul galls have a bluish-brown color, while those from Smyrna are of a blue-gray color. The fourth kind of galls are brought from Trieste and Naples, and are generally of a whitish-red and green color. Sometimes we find inferior galls in the market which are brought from Asia Minor and Dalmatia; they are hollow and very light, having a reddish color, but, as the dyer obtains his nutgalls in the ground state, it is very difficult for him to judge the quality or purity of the galls.

Fehling found that Aleppo galls contained from 60 to 66 per cent. of tannic acid, while Fleck found 58.71 per cent. of tannic acid and 5.9 per cent. of gallic acid.

M. Guibourt's analysis gives, in one hundred parts: woody fibre, 10.5; water, 11.5; tannin, 65; gallic acid, 4; extractive matter, 2.5; starch, 2; sugar, 2; gum, 2.5. Other chemists give, in one hundred parts: tannin, 26; gallic acid, 6.20; gum, 4.80; and the insoluble parts, 63. Sir H. Davy asserts that the best galls do not contain but 26 per cent. of tannin and 6.2 per cent. of gallic acid; tannin and gallic acid being generally found together in the same vegetable substance, it has been conceded by many chemists that the one did produce the other. M. Pelouze to a great extent verifies this supposition, more particularly as regards the tannin contained in nutgalls; he says that if a solution of tannin be kept from exposure to the atmosphere no change will take place; but if left exposed it comes in contact with oxygen, the tannin undergoes a change, and gallic acid is then formed in the solution of tannin.

Nutgalls contain gallic acid as well as tannin, and they will compare, one to the other, as follows: —

"*Gallic acid:*	7 oxygen.	*Tannin:*	13 ozygen.
	3 hydrogen.		8 hydrogen.
	5 carbon.		17 carbon."

These are the re-actions of some of the metallic salts upon nutgalls: —

NAME OF SALTS USED.	COLOR OF THE PRECIPITATES.
"Copperas gives. . . .	black precipitates.
Nitro-muriate of tin gives . .	fawn-colored precipitates.
Muriate of tin gives . . .	straw-colored precipitates.
Blue vitriol gives . . .	yellow-brown precipitates.
Nitrate of copper gives . .	grass-green precipitates."

The combining proportions of nutgalls and copperas are as 4 to 1; that is, one pound of copperas will precipitate all the coloring matter from four pounds of nutgalls.

INDIGO.

Indigo is a substance we find widely dispersed in the vegetable kingdom. The indigo-plant is found in India, Africa, Southern and Central America, Egypt and other parts of the globe; the botanical name of the plant is *indigofero*. The Hindostan indigo is prepared from the plant *Nerium tinctorium*. The following five varieties of the indigo-plant are more particularly employed for making indigo: *Indigofera tinctora*, *I. anil*, *I. disperma*, and *I. argenta*. Indigo is found in the woad plant, *Isatis tinctoria*, which plant is a native of Germany, Great Britain and other parts of Europe. Indigo (or the coloring principle of the plant) is not found in the plant ready formed, but in the leaves, as a secretion or juice, and is generated when the green leaves are pressed and the juice of the leaves is exposed to the action of the atmosphere. Dr. Schunck states that the indigo-plant contains a coloring matter, which he has termed indican ($C_{52}H_{62}N_2O_{34}$), which, by fermentation or by the action of strong acids, is converted into indigo-blue and a peculiar kind of sugar, indigo glycine, and has this formula: —

$$\underset{\text{Indican.}}{C_{52}H_{62}N_2O_{24}} + {}_4HO_2 \times \underset{\text{Indigo-blue.}}{C_{16}H_{10}N_2O_3} \times \underset{\text{Indigo glycine.}}{6\ C_6H_{10}O_6}$$

The plant requires a hot climate and a soil so situated that it will not be liable to inundations. To give a description of the method of extracting the indigo-blue from the plant would require too lengthy an article, besides not being of any material advantage for the dyer's purpose.

The plant from which the Bengal indigo is made is a small, straight one, with thin branches spreading out, and forming a sort of turf, and averages about four feet in height. The leaves are soft, and resemble those of the common clover, having a blossom of a bluish-purple color, and yield the largest amount of indigo when the plant is in full bloom, and the indigo obtained from this plant is considered the best, as there are less impurities in it.

It is not positively known when indigo was first introduced as a dyeing material, but it was known to the Romans and Greeks, who used it as a paint, under the appellation of *indicum.* It was not used as a coloring substance in Europe until about 1640, when it was imported from the Indies by the Dutch, at which time its use was prohibited in England, under very severe penalties, and these penalties continued in force until King Charles the Second ascended the throne; and the reason given for its prohibition was that it had a corrosive nature, and was destructive to the fibre of the wool, for which cause it was an injury to the reputation of the dyers. Probably the above opinion arose from the strong and interested opposition to its use by those who cultivated the woad plant, which at that time was an important branch of national industry, as well as of great profit to farmers and merchants, "and in consequence of the woad depreciating in value, an edict was issued against indigo being used in Saxony, in the year 1650, and in 1652 Duke Ernest the Pious caused a proposal to be made to the diet, by his envoy, that indigo should be entirely banished from the empire, and that an exclusive privilege should be granted to those who colored with woad."

"This edict was followed by an imperial prohibition of indigo, on the 21st of April, 1654, which was enforced with the greatest severity in his domains. The same was done in France; but in the well-known edict of 1669, in which Colbert separated the fine from the common dyers, it was stated that indigo should be used with woad, and in 1737

dyers were left at liberty to use indigo alone, or to employ a mixture of indigo and woad." (*Barlow's Manufacturing and Machinery of Great Britain*). The varieties of indigo in the market are, the Bengal, Guatemala, Madras and Manilla, and are valued as they are named; there are various varieties of these indigoes. The varieties of Bengal indigo are numerous. The superfine or light blue is in a cubical form, light and friable, soft to the touch, gives a clean, smooth fracture when broken, and a beautiful copper color when scraped with a knife. The second kind is termed superfine violet, shows a violet-red color when scraped, and has a smooth cleavage; the third is a superfine purple color; the fourth is a fine violet, in color less brilliant than the second, and somewhat heavier in weight; fifth, fine purple-violet color; sixth, a good violet color and heavier than the fourth; seventh, violet-red in color, breaks with an uneven fracture, and shows mouldy places inside; eighth, a common violet color; ninth a fine and good red color, heavier than the eighth, and a more decided red; the other four varieties grow poorer till they get to the thirteenth variety. The Guatemala indigoes are of five varieties; the best are of a bright blue color, and are very remarkably light and fine, and by some are considered as good as the Bengal indigo, but this is an error; the inferior varieties have a violet color, but there is more of a mixed variety in them than in the Bengal indigoes.

In selecting indigoes every dyer should be on his guard against the defects of greater importance than those named, and these are some of the defects to be instilled in the mind, and to be avoided in purchasing indigo:—do not buy those that have large or small fractures or cracks; those broken into lumps of unequal size, fragments or irregular pieces, and fine enough to pass through a coarse sieve; squares that are easily broken and show a whitish or mouldy substance inside; gritty feeling lumps, having the appearance of granite in the cleavage; those indigoes that have streaks or layers of differ-

ent shades of blue in them, one above the other in the same piece; those that have the appearance of being burned, which, when rubbed in the hand will break into small pieces, almost black in color. Reject the indigo in which the eye can detect shining specks, which are nothing more nor less than sand. The impurities of indigo are iron, clay, magnesia, and silica of a substance resembling gluten. Sometimes you will find in a chest of indigo a quantity of dust that will weigh eight or ten pounds. This dust is an adulteration composed of starch, or of white lead mixed with the powdered indigo, and is put into the chest to give it more weight. Part of the above impurities can be dissolved in alcohol, in diluted acids, alkaline lyes, and even water. By digesting indigo in weak sulphuric acid we obtain a brown-colored matter, which is termed indigo-brown. Indigo also contains other coloring matters, termed indigo-red, indigo-blue, or indigotine ($C_{16}H_{10}N_2O_3$), the particular coloring-matter of the plant for which it is valued.

The quantity of indigo-blue contained in the several varieties of indigo varies from 20 to 80 per cent. of pure coloring-matter.

The quality of indigo is, by most dyers, ascertained by its deep blue color, and lightness in weight. From the great difference in the various kinds of indigo, it is of the greatest importance that the dyer should have an easy and simple method of ascertaining the true or real value of the indigo he has to use; but, as far as I can learn, there has been no such method found out. All the known methods require formal analyses, which, however important they may be to dyers, are too tedious and delicate to be practised in most of the dye-houses in America. The usual method for judging the quality of indigo is by comparison, — placing several pieces together, and breaking and comparing their clean surfaces one with another. The best indigo will be of a deep violet-blue color, and a fine clear grain, and, when scraped with the nail, show a good copper hue. Yet it requires long practice and great

care to be a good judge of indigo by its appearances. In selecting indigo, it requires the closest discrimination, and cannot be made except by a person who, from long acquaintance with the use of indigo, has acquired an experimental knowledge of the value of the different varieties, and that person of all others is the practical and scientific dyer. G. Leuchs found, that in forty-nine samples of indigo, the best kind contained sixty and a half per cent. of pure indigo, and in the poorest kind, but twenty-four per cent. We see by this how difficult it must be to select the right kind of indigo for such and such purposes, and a practical eye and mind only can determine what variety is best for their uses.

Pure indigo, whether it is obtained by sublimation or other chemical processes, will be of a deep blue, verging on the violet shade. Indigo crystallizes only by sublimation at a heat of 550° F. At this heat it emits a crimson-colored vapor, having a peculiar odor. This gas, being caught in a cooled receiver, will condense into needle-shaped crystals of great richness and intensity of color. These crystals will be one-tenth the weight of the indigo employed, and will produce a brighter, clearer, and better color than the crude indigo from which they were obtained. The analysis of some chemists give the pure, or absolute coloring-matter of indigo, as follows: Crum, eighteen per cent; Chevreul, twelve per cent.; Bergman, fifteen per cent. in one hundred parts.

Chevreul gives as the result of his analysis of indigo, first treated with water, second with alcohol, and afterwards with muriatic acid, as follows: —

Treated with Water:

Green matter united with ammonia, . .	12 parts.
A little deoxidized indigo, ...	
Extractive matter, ...	
Gum, ...	

Treated with Alcohol:

Green matter,		
Red resin,	30	parts.
A little indigo,		

Treated with Muriatic Acid:

Red resin,	6	"
Carbonate of lime,	2	"
Red oxide of iron,	2	"
Alumina,	3	"

There remained:

Silica,	3	"
Pure indigo,	45	"
	103	"

Bergman gives in 100 parts:

Resinous matter,	6	parts.
Earthy matter,	22	"
Oxide of iron,	13	"
Mucilaginous matter,	12	"
Indigo remaining,	47	"
	100	

Both of these eminent chemists give nearly one-half the weight of pure indigo as the coloring-matter of the indigo of commerce; but it must be borne in mind, that they obtained a blue powder, and not the crystallizable color; and should this forty-five or forty-seven per cent. of blue powder be subjected to a subliming temperature, they would not have obtained more than from fifteen to eighteen per cent. of crystals of indigo, and these crystals would have given better results as to color than the one hundred pounds of crude indigo used, from which the crystals were separated.

The constitution of indigo, and the proportion of its constituent principles, according to Dr. Ure, are as follows: —

Carbon,	71.37
Hydrogen,	4.38
Nitrogen,	10.00
Oxygen,	14.25 = 100
Water,	16.00
Excess of hydrogen,	2.52

Or thus: one atom of nitrogen, two of oxygen, four of hydrogen, and sixteen of carbon.

Indigo is an insoluble color (that is, in its natural state, and under common circumstances), and is the most permanent of the vegetable colors, it being entirely unchangeable by the atmosphere, and the common agents, such as alkalies, and the rays of light. It will not combine (in its natural state) with any substance, except concentrated sulphuric acid, which acts with such force upon it, that it is converted into another substance; for it is no longer indigo, which is proved by its not exhibiting the same phenomena in any of the known blue-vats, neither by any other method employed for its deoxidation and solution in an alkaline menstruum. Sulphuric acid changes the natural character of indigo completely, as will be seen by coloring with the sulphate of indigo (chemic, extract of indigo), which is one of the most fugitive of dyes, when fixed upon wool or woolen fabrics, although the indigo from which it was prepared is the most unchangeable of dyeing materials or substances. Sulphuric acid changes indigo, and dissolves it without deoxidizing it, and it cannot be brought back to its original state again, forming as it does with the acid, a chemical sulphindigotic acid (sulphate of indigo). When sulphate of indigo is treated with carbonate of potash (KCO_3), there will be formed carmine of indigo, a deep blue precipitate, which is soluble in one hundred and forty parts of cold water. Carmine of indigo has been lately made with refined indigo, treated with strong muriatic acid (HCl), which

dissolves the lime, iron, and other foreign substances in the indigo, and afterwards with a diluted solution of caustic soda ($NaHO$), which will dissolve all other organic impurities remaining, and the result is a greater brilliancy of the colors obtained. If indigo should be put into fused hydrate of potash ($KOHO$), its blue color would entirely disappear, and it would become partly decomposed, along with the water of the alkaline hydrate. Hydrogen and ammoniacal gases are generated, while carbonic acid (H_2CO_3) and another acid, having properties very much like acetic acid ($C_4O_3H_3$) are formed, and they combine with the potash (K). Now digest this mixture with a small quantity of sulphuric acid (H_2SO_4), and the alkali will combine with it, and this will crystallize; then this solution will combine with alkalies and other bases, forming very interesting salts; or, if powdered indigo is added to one part of nitric acid (HNO_3), and eight parts of water (HO), and a gentle heat applied, it will dissolve and form a yellow solution, and by decanting and evaporation, there will be deposited a quantity of yellow crystals, of a sour or bitterish taste. These crystals will dissolve again in cold water, requiring nearly one hundred parts of water to do it. This is now called anilic acid, derived from the name of one of the plants that produce indigo. It will combine with all the known bases, forming salts that have a yellow color, and will give a blood-red color to solutions of nitrate of iron ($3NO_62Fe$). Add indigo to strong nitric acid (HNO_3), and then apply heat, it will readily dissolve, emitting a great amount of nitrous gas (NO_3); allow this to cool down, and a large amount of semi-transparent yellow crystal will precipitate, having a strong bitter taste, which was formerly termed carbozotic acid, but is now called picric acid, of which we will give a detailed account under the head of picric acid. Chromic acid (H_2CrO_4) has nearly the same action upon indigo as nitric acid. If powdered indigo be mixed with a solution of caustic soda ($NaHO$) of a specific gravity of 70° Twaddle, and then boiled, we find that an orange-yellow salt is precipi-

tated, and that the supernatant liquid becomes blue by the absorption of oxygen from the atmosphere, the same as a solution of white indigo or reduced indigo ($C_{16}H_{12}N_2O_2$), this being the same result as coloring in the blue-vat.

If indigo is mixed in water with any metallic salt or sulphuret, possessing more affinity for oxygen than indigo does, a change takes place in their respective substances. The indigo will pass from a blue to a dull olive color; this result having been produced by the abstraction of that portion of oxygen that constituted the indigo a blue color, and the salt or sulphuret has become oxidized. Now if an alkali (lime) is added to the mixture, we will perceive a different appearance. The indigo having become dissolved in this alkaline solution, the whole now exhibits the well-known characteristics of the blue-vat. The substances named are such as are used in vats for coloring cotton fabrics, and the operation, is as a general rule, performed in cold solutions; and whatever means we may employ for deoxidizing the indigo, in order to apply it as a permanent dye, the substances used must all be based upon the abstraction of more or less of the oxygen contained in the indigo, and its solubility, while in that state, in an alkaline solution. When we dip an article of either wool or cotton in the blue-vat, it comes out of the vat of the same color as the solution; but as the tendency of indigo is to retain that particular amount of oxygen which constitutes it a blue, it will immediately absorb that gas from the surrounding atmosphere, on which re-absorption of oxygen it will return to its natural state (blue) unaltered in any of its properties, as an insoluble and unchangeable color.

If indigo is placed in contact with any substance or substances that have a strong attraction for oxygen in the presence of an alkali, it will be reduced to the white state, and become soluble in the alkali; this is the result and principle of the blue-vat. There are numerous substances that will reduce indigo to the white state, such as—

Protoxide of tin,
Protoxide of iron,
Sulphuret of arsenic,
Phosphorus,
The phosphites,
Sulphites,
Sodium,
Sugar,
Starch,
Calcium,
Turpentine,
Boiling paraffin,
Spermaceti,
Stearic acid,
Chloroform,
Hydro-sulphite of soda,
Metallic zinc and soda-ash,
Soda-ash lye, with oil of vitriol and tin crystals.

Or add sulphurous acid to caustic soda, then kill the solution with zinc. This is hydro-sulphite of soda. Add this to the ground indigo, and wool or cotton can be colored in it.

Take two parts of carbonate of soda, and one part of sulphur, mix them together, digest it in water, filter, and add flowers of sulphur, boil and filter. If indigo is ground in this, it is reduced, and can be printed upon cotton, and in a short time will oxidize and become fixed upon the cloth. Take one part of ground indigo, and three parts of hydro-sulphite of soda ($NaOS_2O_2$); use carbonate of soda enough to keep the indigo in solution. All these materials will reduce indigo to the white state, and then woolen or cotton fabrics can be colored blue in their solutions.

MUNJEET.

This dyeing substance is a species of the plant *Rubia tinctoria*, and is cultivated in the East Indies. It is imported in bundles, and ground into a fine powder for the use of the dyer. These bundles consist of thick and thin stems, or stalks. The thin stalks are said to contain less coloring-matter than the thick stalks, and the bark is left on, while the thick stalks are stripped of the bark. They are very dry,

light and porous, and when broken exhibit a red-orange color. The powdered munjeet is composed of the thick and thin stalks mixed. The color given by it is equally as permanent, and far handsomer, than that given by madder.

This dyestuff is not used as much as formerly for reds (for which it was chiefly used), it being superseded by the aniline reds and purpurine reds. It has been tried as a substitute for madder in the woad-vat, on which point dyers are not agreed, but never having used it in the blue-vat, we are not willing to pass our verdict for or against its use in the woad-vat. In coloring red with munjeet, the manipulations are the same as when using madder for the same color. It bears the solutions of tin much better than madder, as it requires a certain amount of tin solution to give the color obtained by it the greatest brilliancy and perfection. Munjeet does not appear to contain the different and distinct coloring-matters that madder does. It has not the same taste, but the color that is given by it is a more desirable red, with less of the orange-yellow tint to it, than that produced by madder. The proper mordants for munjeet appear to be alum, tartar, and oxalic acid; then in the solution of munjeet (or in the finishing bath) add some nitro-muriate of tin liquor. The quantity of color obtained in this manner is equal to that obtained from the same weight of madder.

Munjeet is described by Roxburgh, in his treatise on the *Plants of the Coast of Coromandel*, as the *Rottlera tinctoria*, a small tree from twelve to fifteen feet in height, growing throughout Hindostan, in several of the East India islands, in China, and in Australia. The fruit it bears is a roundish, three-valved, three-celled capsule, of the size of a small cherry, having three furrows on the outside, and thickly covered with a red powder. This fruit is used as a medicine by the natives. The fruit of this plant is now largely used as a medicine in Great Britain, in cases of tape-worm, its properties as a vermifuge being first investigated by Dr. C. Mackinnon, a British army-surgeon in India, who published the re-

sults of his observations in the "Indian Annals of Medical Science," in 1854. He says: "I have used this fruit in fifty cases for tape-worm, and failed in bringing away the worm only in two instances." The testimony of other practitioners in India and Great Britain goes to confirm the statements of Dr. Mackinnon, so there can be but little doubt of the powers of this fruit as a vermifuge.

But we will return to the description of it as a dyeing-material. Munjeet, as we have remarked, is received by the dyer in a powdered state; its color is a brownish-red, having very little odor or taste, but it produces, when chewed, a slight sense of acrimony in the mouth, and has a gritty feeling to the teeth. It will flash like gunpowder when dropped into the flame of a candle. It is insoluble in cold water, but slightly soluble in hot water. It requires considerable boiling to extract all its coloring-matter. It is readily dissolved in alkaline solutions, which give a resinous precipitate, on the addition of an acid to the alkaline solution. Under the microscope, Mr. Hanbury found it to consist of "garnet-red, semi-transparent, roundish granules from $\frac{1}{500}$ to $\frac{1}{250}$ of an inch in diameter, more or less mixed with minute stellate hairs, and the remains of stalks, which were easily removed by careful sifting." Munjeet was chemically examined by Dr. Anderson of Glasgow, who gave its constituents: 78.19 of resinous coloring-matter, 7.34 of albumen, 7.14 of cellulose, &c., a trace of volatile oil and volatile coloring-matter, 3.84 of ashes, and 3.49 of water, in 100 parts. He also obtained a coloring substance in a pure state, by allowing a concentrated ethereal solution to stand for two days, then draining it, and pressing in bibulous paper the resulting mass of granular crystals, and purifying them from adhering resin by repeated solution in ether, and crystallization. To this substance he gave the name of *rottlerin*. "Rottlerin melts when heated moderately, and at a higher heat it will decompose, and emit pungent vapors." "The formula of rottlerin, ac-

cording to Dr. Anderson, is $C_{22}H_{10}O_6$," making its prime equivalent = 190.

MUREXIDE.

This is a fine purple dyestuff, and was first obtained by the action of nitric acid upon uric acid; it was, however, supposed by Mr. Prouty to consist of purpuric acid and ammonia, and hence he named it *purpurate* of *ammonia*, but chemists are not agreed as to its precise composition. It was first prepared from uric acid, transformed into *alloxane*, by gradually throwing the uric acid into nitric acid, care being taken that too great an elevation of temperature is not allowed. This mixture is then allowed to cool, after thirty-six hours the *alloxane* commences to crystallize, and after its separation from the excess of acid, it is then re-dissolved in water and allowed to crystallize a second time. Anhydrous alloxane has the following formula :—$C_3H_4N_2O_{10}$.

Alloxane in solution will color copperas an indigo-blue color, colors litmus red, and gives to wool a purple-red color, which will change to a violet by soap or alkalies. The alloxane obtained as above is dissolved, and there is then added to the solution carbonate of ammonia $=NH_4O,CO_2$, drop by drop (the solution of alloxane being boiling all the time), until the solution has a slight smell of ammonia. By this operation carbonic acid $=CO_2$ is evolved, and then there is a deposit of crystallized murexide $= C_{12}H_6N_5O_6$.

Murexide is now generally made from guano, which is first treated with muriatic acid $=$ HCl, in order to remove the foreign substances that the guano contains; it is then treated with soda $=$ Na, to dissolve the uric acid, which is separated by neutralizing the soda with muriatic acid; the uric acid thus obtained is dissolved in nitric acid $= NO_5$; the solution is heated, and after it cools, ammonia $= NH_3$ is added, which develops the purple color. Murexide crystals have a square

form, and are of a rich green color when viewed by reflected light, and show a purple-red color by transmitted light. Murexide is slightly soluble in cold water, but more soluble in boiling water; it is insoluble in alcohol and ether. With potash it forms a rich purple solution, and, if heated, the murexide will be decomposed. With zinc mordants orange and yellow shades are obtained; with the sub-acetate or acetate of lead, it gives a purple-red color. All the colors given by this substance are very beautiful, but are as fugitive as they are beautiful. The colors obtained by murexide had a great success, until the aniline colors were discovered. See for an article on the subject of murexide the "Pharmaceutical Journal," vol. xviii, p. 328.

SAFFLOWER.

This is an annual plant, and was formerly called *dyer's saffron;* it is the flowers of the *Carthamus tinctorius*, a thistle-like plant, and belongs to the family of the *synantheræ*, a native of India; it is cultivated in Egypt, the southern parts of Europe, and also to some extent in parts of Germany. It has a smooth, erect stem, somewhat branched at the top, and grows to the height of two feet; the leaves are alternate, and furnished with spiny teeth, similar to the common nettle. The flower only of this plant is used for dyeing purposes. "When the flowers are gathered, they are first pressed to extract the juice; then they are washed in spring water; then they are pressed between the hands in small quantities, and laid upon mats to dry. These cakes are covered up during the daytime to prevent the sun from shining upon them, which would not only destroy the color, but dry the cakes too much, and thereby cause further deterioration. They are kept exposed to the dews of night, and turned over occasionally, until dried to the proper point, and are then packed for

the market, and in this state are usually received by the dyer."

The dyer, at the present time, obtains this drug in the form of an extract of safflower, or more correctly termed, safflower-carmine.

The quality of this substance is better, according to its greater purity from mechanical admixtures, such as the seeds of the plant, and leaves of the plant.

The flowers of the safflower are first exhausted in a weak solution of carbonate of soda, and in this solution strips of cotton are dipped: then immersed either in vinegar or diluted sulphuric acid, for the purpose of neutralizing the alkali (soda). The cotton when taken out of this solution is colored red, and is now washed in a very weak solution of carbonate of soda, and the solution thus obtained is precipitated with acid; it is then called carthamine. The carthamine thrown down by this operation, is first carefully washed, and then placed on porcelain plates to dry.

Carthamine, *or rouge vegetal* ($C_{14}H_{16}O_7$), after it has been repeatedly dissolved and precipitated, is then called safflower-carmine. Carthamine when seen in thin films, has a gold-green hue, but when viewed against the light, it exhibits a red color.

Safflower contains two coloring principles, or matters; the one red, and the other yellow; the red has been termed carthamine, and is insoluble in water; the yellow is soluble in water; there has as yet been no term or name given to the yellow coloring-matter in safflower.

Carthamine, mixed with French chalk (*silicate of magnesia*), forms the cosmetic powder called *rouge*.

Safflower is very often fraudulently mixed with saffron, which it resembles in color, but saffron can be distinguished from safflower by its tubular form, and the yellowish style and filament which they inclose.

There is a tree, a native of China, called *Gardenia grandiflora*, the fruit of which contains the same yellow coloring-

matter that the safflower does, which is employed to dye the yellow robe of the Mandarins. In a chemical examination of this fruit, in the laboratory of Rochleder, the result was the discovery of a coloring substance which proved to be identical with that of safflower, and to which the name of *crocin* was given; this crocin, in powder, is of a bright-red color, and is soluble in water and alcohol. By treating this powder with muriatic acid, it yields another coloring-matter called *crocetin*, which is the true coloring-principle of the fruit.

There is a substance in the market called saffranine, used as a substitute for safflower, but we have as yet had no experience in its use, and therefore cannot speak of it with confidence; but those dyers who have used it say that it is equal to safflower in brightness, and is more permanent. In coloring cotton, the liquor of the safflower is used as extracted from the plant. The yarn is to be well bleached first. One pound of the safflower is used to one pound of yarn, and this proportion makes a dark rose. It must be borne in mind that the water must be as pure as possible for coloring with safflower, and used cold. A very little heat will destroy the color, and the yarn must be dried in the shade, but not with artificial heat. The colors produced by this material are the most beautiful that can be made upon cotton, although very fugitive. Beautiful lavenders and lilacs can be colored on cotton with safflower and prussiate of potash, by first coloring the yarn a Prussian blue, then topping off with the safflower; but there is great difficulty in obtaining equal colors. In this process, the blue must be put on with prussiate and copperas, and not with prussiate and nitrate of iron, as the nitrate of iron acts upon the safflower by oxidizing and destroying its beauty and depth. The copperas is not so corrosive as the nitrate, and will preserve the peculiar tint of the safflower much better. In dyeing silk with safflower a pink shade, the silk must first receive a *bottom;* that is, it must first be passed through a weak solution of either archil or cudbear, so as to give it a light lavender or flesh color, the depth to be governed by the

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shade of pink wanted. It is then passed through the safflower solution, to which has been added a very little citric, acetic, or sulphuric acid. After the silk has taken up the color from the solution, it is washed in cold water, then washed again in another clear water made slightly acid either with citric acid or cream of tartar. Sulphuric or acetic acid should not be used in the last washing.

The safflower solution for dyeing silk is prepared by passing some cotton-yarn through the safflower extract. The cotton-yarn takes up nothing except the red. This cotton-yarn is then thoroughly washed in cold water till the water coming from it is perfectly clear. The yarn is then steeped for a short time in water made slightly alkaline with carbonate of potash, which extracts the red from the cotton-yarn. This solution is the dye for the silk.

Like cotton colored by safflower, silk must be dried in the shade, care being taken that the sun's rays cannot strike it. If all necessary precautions are not taken, the dyer will have the trouble of putting the cotton or silk through the last acid-water, if not have to re-dye it altogether. Many chemists object to the theory that carthamine, or the red coloring-substance of safflower, is the oxide of a colorless base, as we have observed in regard to woods, and some of their investigations and reasoning bear evidence of care and judgment, thus adding an interest and inciting practical dyers to a more skilful investigation upon the subject of vegetable coloring-matters.

VALONIA, OR VALONEY-NUTS.

These are the cups of the acorn from the Valonia oak, which grows wild in the Dardanelles and the islands of the Archipelago, and in Asia Minor. They are imported from Smyrna and its vicinity in great quantities. They contain a large amount of tannin and gallic acid. Valonia-nuts are

inferior to nutgalls and sumac for coloring cotton, but for wool-dyeing they are as good as sumac or nutgalls. For silk-dyeing they possess some peculiarities which are exceedingly valuable, especially for blacks, giving a black on silk more permanent than that obtained with nutgalls, and, moreover, the producing of the proper black with this substance upon silk requires a peculiar and certain method, which a very few dyers have attained.

The Valonia-nut is used now only for coloring hats black, for which purpose it is superior to sumac or nutgalls, as it withstands the different operations which felt-hats are subjected to much better than the galls or sumac.

WELD, OR WOLD.

This is an annual plant, extensively cultivated in France, and other parts of Europe, for the purpose of coloring yellow. Its botanical name is *Reseda luteola.* It is an inodorous plant, having a bitter taste, which is very adhesive. Chevreul obtained from it, by sublimation, a peculiar yellow coloring-matter, which he called *luteolin.* It is still largely employed in France for coloring yellow, but since the introduction of quercitron-bark, and flavine into England, it has not been used there, neither is it now used in America. It is found in the market in small, dried bundles. The more slender the stems are, the better it is considered for dyeing-purposes. The plant grows to the height of three feet, in straight stalks or stems. Both the stems and seeds are used, as they both contain the coloring-matter, but the seeds are said to contain it in a greater quantity. The coloring-matter approaches very nearly to that of quercitron in chemical properties, and of all the vegetable dyes it is the least acted upon by acids and alkalies, which gives to the color produced by it, as far as these substances are concerned, great permanence.

But it has this counteracting disadvantage, that the color fades rapidly, or will pass away when exposed to the action of the atmosphere and light. Under these influences it becomes oxidized, for which reason it has been abandoned as a dye.

A solution made from this coloring-substance is of a yellow color, with a reddish tint to it, and has a very bitter taste, with a peculiar smell. It has the following re-actions:—

Sulphate of iron gives a yellowish-olive precipitate.
Muriate of tin gives a yellow precipitate.
Alum gives the same result.
Acids darken the yellow; and
Alkalies change it to a bright yellow.

The mordant that produces the best results (or the most proper preparation) is alum and tartar, in the proportion of three of alum and one of tartar to every fifteen pounds of clean wool, and boiling the wool two hours. The color given by using the above mordant always inclines to the lemon-shade, but the color is of such softness and purity that no other dyeing material equals it (aniline dyes excepted).

The different solutions of tin can be used, along with alum and tartar, when coloring yellows on yarn or flannels, but would be objectionable for goods that have to be fulled, because the solution of tin will give a precipitate or color with weld, that will not penetrate the body of the cloth sufficiently for such fabrics as have to be fulled.

Weld had been used for coloring woolen and silk long before it was used on cotton fabrics. We quote from Dr. Bancroft this clever fraud in regard to the use of weld in coloring yellow and green on cotton goods: —

"In 1773 the sum of £2,000 sterling was granted by parliament to a Dr. Williams, as a reward for his discovery of a fast yellow and green dye upon cotton yarn and thread.

"This supposed fast dye was given by the combination of weld with a certain mordant, the composition of which the

patentee was permitted to conceal, that foreigners might not enjoy the benefit of his discovery; while he, on his part, engaged to supply the cotton and thread dyers with his dye at a certain fixed price. The mordant used was supposed by chemists to be a solution of tin alone, or of tin and bismuth, which gives to weld-yellow the power of resisting the action of acid and boiling soapsuds, although it is not proof against the continued action of the sun and air.

"This defect, however, was not easily discernible, in consequence of the ingenious method which the inventor employed to obtain a favorable testimony of the dyers upon the subject. He caused his specimens of dyed yarn to be woven into pocket-handkerchiefs, and gave them to be worn in the pockets of those who were afterwards to attest to the goodness of his dye; and, as handkerchiefs worn in pockets were not exposed to the action of sun and air, this want of permanency was not discovered until some time after the reward was paid for an invention which proved of little or no value."

Weld should be stored in a dry place and kept free from dirt or the admixture of other dyestuffs.

PASTEL.

The pastel is a plant cultivated in France, Germany, England, and Saxony, but is cultivated in France more extensively than in either of the other countries named, and, not unlike woad, it is distinguished in the different varieties according to the localities from which we receive it. Pastel, like woad, contains a blue coloring-matter, also a fawn-colored yellow substance; these matters can be separated from the pastel and woad by treating them with hot water before the fermentation takes place in the operation of *couching*.

We are indebted to M. Chevreul for the analysis of the pastel, which gives us some light upon its use. He says: —

"When the leaves are subjected to the action of the press there is obtained, on the one hand, a residue of a ligneous nature, and, on the other hand, a juice, which holds in suspension sundry matters which give it a cloudy appearance. Thrown upon a filter, it leaves a greenish matter, or fecula, which is formed of wax, indigo-blue, and a nitrogenous substance. The clear liquid, after passing through the filter, contains this nitrogenous substance coagulable by heat; a nitrogenous substance non-coagulable by heat; a red matter, resulting from the union of the blue coloring-principle with an acid; a yellow principle; gummy matter; some liquid sugar; a fixed organic acid; free acetic acid and acetate of ammonia; a volatile principle, having the odor of osmazome; citrate of lime; sulphates of lime and potash; phosphates of lime; magnesia; iron and manganese; nitre, and chloride of potassium."

It appears that Chevreul did not find in the above products any substance which possessed the power of seizing upon oxygen with energetic force, and which explains the action that pastel has in the blue-vat. Yet there is no doubt but what the principles furnished by the pastel intervene, that is to a certain extent, as combustibles, and we must refer at least a part of their effect to this manner of action. For the pastel-vat the indigo should be of the very best quality, — the Bengal indigo having been proved by dyers most conversant with working pastel to be the cheapest and best; and, in fact, a dyer will use no other in a pastel-vat, if it is possible to obtain it.

Before indigo was introduced or known in Europe, pastel and woad were the blue-dyeing materials, and were known as such by the Greeks and Romans.

Pastel is a biennial plant, and is a species of the *Isatis tinctoria;* its leaves have a fugitive, pungent odor and a very acrid taste.

The leaves of the pastel have been used by physicians in jaundice, scorbutic affections and like diseases.

The distinction between pastel and woad is not very clear. Schutzenberger says: "Pastel, woad, and *Isatis tinctoria* is a plant of the family of the *Crucifera*. It would seem, however, that the term *pastel*, as used by the old French dyers, is applied to the leaves of the woad which have been fermented, formed into paste, and afterwards into balls, and which contain much blue coloring-matter. And the term *woad*, as distinguished from *pastel*, is applied to the unfermented plant." We cannot see the propriety of this distinction, and for this reason, that the woad plant has to go through a fermentation process, to a certain extent, before it is put into casks and sent to the market, &c. (See article, Woad, in this work.)

WOAD.

Woad is a biennial plant (the same as pastel), called by botanists *Isatis tinctoria*. The leaves of this plant have a pungent odor, and an acrid taste, and were long employed for coloring blue, before the introduction of indigo; and when indigo was first introduced in England and Germany, about the year 1645, only a very small amount of it was mixed with the woad. Afterwards a greater quantity was added, and by the use of indigo, the farmers, merchants, and others in England and Germany lost a production by which they had become rich, as, after the introduction of indigo, woad was not in so great a demand, and the result was, a prohibition was first issued in Saxony against the use of indigo (April, 1650), and in 1652, Duke Ernest sent a proposal to the Diet, that indigo should be totally excluded from his empire, and that the exclusive privilege should be given to those dyers who used the woad, without indigo, for coloring blue.

"This was followed by an imperial prohibition of indigo, on

the 21st of April, 1654, which was enforced with the greatest severity in his domains."

"The same was done in France; but in the well-known edict of 1669, in which Colbert separated the *fine* from the *common* dyers, it was stated that indigo should be used without woad, and in 1737 dyers were left at liberty to use indigo alone, or to employ a mixture of indigo and woad."—*Barlow.*

We will abridge from "Gibson's System and Science of Colors," his remarks upon woad: "This plant, which when made into a fermented paste is called woad, has been used as a coloring material (either to stain the bodies of the savage Britons, or to color the garments of their more civilized descendants), for two thousand years, and the accumulated experience of ages, transmitted from father to son, hath given to the artisans of that country a mass of practical information regarding its manufacture and mode of operation, that those of no other nation possess."

"The woad plant is cultivated in England, France, Germany, and other European States, and when the cultivator thinks the plant is sufficiently matured, it is cut, then ground into a pasty mass, which is piled into a heap, when, after a time, heat is generated, and fermentation commences, with the disengagement of ammoniacal gas. During the progress of this process, the heap is turned or worked over, sprinkled with water or lime, as the operator thinks best, in order to regulate the temperature of generating heat, and to retard or accelerate the fermentation, as the case may be."

"This operation is continued at intervals for two or three weeks, according to the state of the weather, and other circumstances. This process is termed couching."

"Couched woad, differs from pastel or ball woad, inasmuch as the pastel is merely the ground plant made up into balls, and then dried in an open shed, without being fermented or couched, as above described." (See article, Pastel.) "The process of couching is the act whereby the separate and dissimilar parts of the plant are converted into a coherent and

homogeneous substance, possessing very active powers, and as the operation of this material (now called woad) is the cause to which we must look for all the phenomena presented by the woad-vat, we should inquire into the nature of the change that has taken place, or ascertain in what state the article exists."

"When the recently ground plant is piled in a heap, and the process of couching has commenced, the operation that is going on is precisely the same as that which takes place in a dung-hill when that is allowed to ferment."

Chemists divide fermentation into three classes or species: first, the vinous; second, the acetic; and third, the putrefactive fermentation. The vinous fermentation is that which will convert all saccharine substances into carbonic acid and alcohol. The acetic fermentation is that which will convert sugar or alcohol into vinegar; and the putrefactive, is that which converts organic substances into earthy matters, which remain, and into inflammable gases, which are absorbed by the atmosphere.

"It is for us to determine whether the process of couching the plant belongs to any of the species mentioned above, or whether it does not constitute a fourth species or state of chemical action, which has not been examined or explained by any of our chemical writers, in describing the phenomena of fermentation."

"It is certain that it is not the vinous action, for there is no carbonic acid given off, neither is there any alcohol formed. It is positive that it is not the acetic, there being no production of vinegar; and it is not the putrefactive process, for it neither evolves fetid or inflammable gas, nor does it leave an inert, earthy residuum, but, on the contrary, it exhales a fragrant, exhilarating uninflammable ammoniacal vapor, and the remaining substance is remarkable for its energy."

"These facts are positive evidence that it differs entirely from and does not belong to any of the above species of fermentation; that its products are not similar, nor the substance

like any of the three; and seeing that it is fermentation, it must, of necessity, constitute a fourth species, whose characters are as well defined, and whose features are as distinctly marked, as any of the others, and it devolves upon us to show what these characters are, in order to assign it a location and give it a name, in the scale of fermentation."

"When the couching process of the woad is proceeding in a regular manner, a great quantity of ammoniacal gas is evolved from the fermenting mass, and all the tendencies of the process are to the production of alkaline properties, and this continues until the process ceases, when the remaining substance (now woad, still exhaling ammonia), retains very energetic qualities, which continually produce fresh alkali. Therefore, we define these energies, from the nature of their products, the *alkaline* state of fermentation."

"Such, then, is the nature of the process of couching (and also of the proper fermentation of dung), for the products and energies at work are identical, in both cases. As we shall show in the sequel, the alcoholic and acetic kinds of fermentation, both pass into the alkaline species, before running to putrefaction. This circumstance marks out the position which the alkaline process occupies, as the one immediately preceding the putrefactive state, or that particular act which completes the entire destruction of the matter subjected to fermentation."

"And as the alkaline process approaches so near to the putrefactive (there being but a step between it and destruction), this shows the great skill and care that are required in the workman to prevent such a catastrophe. Hence the difficulty experienced in the working of woad-vats is not to be wondered at."

"We will now describe the marketable qualities of woad, so as to enable the dyer to make a judicious choice of such specimens as are good and safe to work. There are three general appearances of cask woad, only, that we shall notice: the brown or foxy, the dark-colored and muddy-formed

woad, and the fine olive-green colored and fragrant-smelling woad."

"The best woad is of a green-olive color, interspersed with parts of a browner appearance. It is rather tough and adherent, than otherwise. When a piece of it is broken open, it shows fine silky filaments of considerable tenacity. It has an agreeable and sweetish ammoniacal odor, and when mixed with water, it does not very easily dissolve or fall apart, but has a doughy toughness, and requires considerable stirring to convert it into a light, pulpy substance. When so dissolved, its soluble portion imparts to water a deep brown color, inclining to olive, and the liquor has considerable substance or body."

"These are the distinguishing characteristics of good woad, and show that the couching has been properly conducted."

"The brown or foxy woad differs in appearance from the preceding description, chiefly in color, which is redder, or more of a decided brown. It has a stronger and less agreeable odor; in other respects it answers the description of the greener, or more olive kind, if the article is good."

"A first-rate foxy or brown woad is much stronger than the one described as the best kind, but it is a very difficult woad to work, as it comes on or springs in so rapid a manner, that it requires more watchfulness and skill to bring it into good working order, than it requires for the other kind of woad; and, moreover, it requires a larger amount of ware, and as its fermenting powers are so strong, it will take sudden plunges of violent fermentation, requiring considerable skill to overcome; therefore, this kind of woad is very unsafe in the hands of an inexperienced dyer; but when it is once fairly brought under subjection, it will execute better work than the other kind, and on this account, for our own use, it is preferable."

"The great cause of the impetuosity of this woad is owing to its not having been fermented enough in the process of couching, and its red color may possibly arise from the plant being too ripe when it was gathered."

"We must now caution purchasers against the worst and most worthless kind of woad, which we find sometimes in the market. It is a heavy, lifeless, dark mud-like article, and is in the state of paste, very mobile, having little or no adherence in its parts, or possessing any tenacity, and does not hold together, but breaks off without any filamentary or fibrous appearance. It is short and earthy, and its odor is similar to that of dock-mud."

"On being thrown into the hot water in the vat, it easily falls apart, and requires little if any raking. The appearance of the liquor formed by it is gray-colored, wavy, glistening or shining as though it was greasy, looking like strong, dirty soap-water."

"The odor of this liquor is vapid; it operates fitfully, sometimes it springs itself quickly, at other times it comes reluctantly to work; but what distinguishes it most is, that after working feebly for a certain, but short time, it suddenly, and without any assignable cause, ceases to operate; the indigo precipitates, the liquor becomes thin, odorless and flat, and no common means have the least effect by way of imparting energy to the materials of the vat."

"The cause of the bad effects of this kind of woad is, that in the process of couching it has suffered too great a degree of heat, and the greater part of it had passed into the putrefactive state, and very little fermenting power remained in that which was uncontaminated by it."

"The good or bad qualities of woad do not depend so much upon the country that produces it, as upon the care and skill exercised in manufacturing it. And the difference, both in the mode of operating and in the price of English and American woad, is entirely owing to the latter circumstance, for we can speak from long acquaintance with the two, that the quality of strength is decidedly in favor of the American woad."

"We will now take into consideration that operation of woad which makes it such an important article in the compo-

sition of the woad-vat; viz., the fermentation of woad in the blue-vat."

"But before proceeding it will be necessary to give a slight outline of fermentation in general, of which genus the operation of working a woad-vat is a species. This description appears to be requisite, to enable the operator to understand the nature of the intestine action going on among the materials of the vat."

"Fermentation is a spontaneous effort of the ultimate constituents of matter to change their state, and enter into different combinations or forms; and this action is independent of, and distinct from, those simple affinities that dispose acids and alkalies to unite so as to form salts, and does not depend upon antagonistic principles mutually exerting their forces upon each other, giving birth to inert compounds, possessing no particular properties; but it is, in the abstract, a true combustion. Though silently and invisibly performed, it is nature's method of analysis, whereby compound and heterogeneous bodies are decomposed and resolved into simpler forms of matter, a process that attenuates and disperses substances, causing the solid to become fluid, or the fluid to assume the gaseous form. It is that operation which performs, in the same order, but in a slower manner, all the agencies of fire; first driving off the most volatile parts, next attacking the liquids, and converting them into gases, it disperses these in like manner; and finally, the more solid parts undergo a similar change, and are ultimately dissipated, until nothing remains but the incombustible and intractable earths, or metallic oxides. Therefore, all the tendencies of the process of fermentation, from its commencement in the alcoholic stage, to its final cessation in the putrefactive, are to what we call destruction, or, more correctly speaking, to the entire separation and dispersion of the combustible constituents of the matters subject to its action; and so progressive and effectual is this dissolution, that no calorific influence, however powerful, could have accomplished it more certainly; for it does, when

suffered to pass through its different stages, produce exactly the same results as destructive distillation."

"Wherefore, reasoning from a similarity of results in the two cases, we have to concede that the passage of what we designate as caloric, or heat, into the body of the materials subjected to fermentation, is the cause of the effects we perceive, arising from that process; and although the sensible heat of the fermenting body may not, in many instances, exceed the temperature of the human frame, yet this is no proof that as great an amount or degree of heat has not passed through the fermenting mass, to effect its complete decomposition, as it would have done had it been exposed to the direct action of fire, in a retort, by the process of destructive distillation, because the fermenting mass obtains its caloric only by its own intestine motion, and from an internal source, and this being carried off as fast as it is generated, by the amount of vapors or gases to which it has given elasticity, is kept comparatively cool, while the matter subjected to destructive distillation, being supplied with its caloric from an external source, and as it continually receives fresh increments of heat, in greater quantity than can be carried off by the ejected gases, it possesses, in consequence, an elevated temperature."

"We assert, that no more heat or caloric has been taken up by the matter exposed to destructive distillation, in order to dissipate its constituents, than there has been required to disperse, in like manner, the gaseous products of common fermentation; for it requires only a certain quantity of heat to maintain matter in a certain state (whether solid, liquid, or aeriform), and when that specific quantity has passed into it, it admits of no further addition; in other words, the capacity of bodies for heat is limited by the nature of their constitution."

"If, then, so great an amount of caloric has been required to change the form of the fermenting matter, and if it has received none from any external source, the question will

naturally suggest itself, whence came this heat, or, how did it originate?"

"In answering it, we will proceed on the data, that the universal presence of electricity, or the galvanoid fluid, is the all-pervading, all-surrounding force, quality or power, that penetrates and envelopes every particle of matter, however or wherever situated; it is an atmosphere or medium extending through and beyond all systems and worlds, possessing an all-present existence, in which all material nature is immersed; it is that principle by which the several elements of matter, having different capacities, assume, by the force of its powers, different volumes, and by it retain their separate existences; it is that imponderable cause which shines in the light, warms in the heat, and lives as the life of all things."

"To this inexhaustible source of effects, we are to look for the cause of fermentation, by understanding that the action of this principle upon the several elements of nature, in causing them to assume different forms, shapes or combinations, is sufficient to account for all the phenomena by that process."

"The presence of electricity everywhere; the various capacities or attractions of bodies for it, and its continual tendency to an equal distribution of its power, or an inclination to find a level or equilibrium, make it the ever-active and all-controlling agent in the operations of nature."

"That this imponderable element exists in all bodies, and that its greater or less amount in any particular body, determines the existence of that body, as a solid, a liquid, or a gas, and that the sensation which we call heat, and to which it is customary to attribute these effects, is nothing more than a result, or mere sensation, whereby we perceive or experience the passage of this element from one substance to another, as it resumes that equilibrium, which had been disturbed by the unequal affinity of the different species of matter for it; and as this passage is more or less rapid, or in greater or smaller quantity, so is the degree of heat or sensa-

tion excited, more or less acute or intense; until, finally, when this change is effected in large quantities, and with great velocity, light is evolved, or the property of shining is communicated to bodies through which this energy is passing."

"Therefore, heat and light have no existence, independent of electrical (or galvanic) changes, and they are not matter in any of its species or forms, but simply sensible perceptions, or visible manifestations to us of changes taking place in matter, by the operation of an energetic power; they are only effects of a prior and greater cause—simple results flowing from velocity of motion—mere sensations of vibrations among ultimate particles."

"And although both light and heat can and do exist, separately, distinctly, and independently of each other, and one is perceived when the other is not present; yet can this seeming irregularily of the violent passage of the electrical power, producing simultaneously both light and heat, be reconciled, on the idea of the peculiar nature that some bodies or substances inherit to throw off both light and heat, and other bodies only inherit but one of these sensations."

"All the effects which are attributed to light and heat could be accounted for on the above theory, were we giving a dissertation upon the phenomena of light and heat, instead of an inquiry into the cause of fermentation; yet the nature of the inquiry has unavoidably led to observations respecting them, and although irrelevent to the subject, they were necessary to illustrate it more clearly, and to enable us to draw the line of distinction between cause and effect."

"Seeing, then, that an atmosphere of electricity surrounds the heterogeneous mass when first placed together for fermentation, and that its equilibrium is constantly disturbed by the changes going on through all nature, it is evident that a discordant mixture (of different principles) cannot long remain without changing, but that a spontaneous change will take place in consequence of the dissimilar capacities of the several substances (contained in the mixture) for electricity.

"This change or motion gives rise to the sensation, heat; the temperature of the mass rises, and the electric power or fluid (or whatever other phrase we might use) combining to saturation with its most susceptible parts, carries them off in volatile products; and as the fermenting substance is continually drawing off the electricity from external nature, with which it is in contact, and as every moment renders it more and more dissimilar in its composition or capacity for this power, the rapidity of the motion becomes more and more energetic, until, as it passes with increasing velocity through its different stages, the action becomes (in some cases) so violent and intense as to set fire to the mass."

"Hence the great difficult of stopping or retaining the fermentation, at any desired point, increases with the progress of the fermentation.

"If we agree with the observations herein expressed, we must admit that electricity is the exciting cause of all the changes that take place in fermentation, as are all the different changes in nature due to electricity."

We will now proceed to describe fermentation in its several or different species and stages of its progress.

"It has been shown that the exciting cause of fermentation is due to electricity, and we have also seen that the whole tendency of fermentation, from its commencement to its close, was to decompose and dissipate the constituents of the substance exposed to the operation of fermentation; and that in this process towards destruction it gives rise to different products, which, by the distinctness of their characters, serve as *criteria* of the several stages of the process, and point out to us just how far the operation has advanced towards its final accomplishment.

"These different stages are termed species of fermentation; but none of them can occur in an uncombustible body. As fermentation is an actual, though invisible combustion, its phenomena can only be exhibited among combustible materials,

or in such bodies as have the power of taking the gaseous state."

"We have termed the different species or kinds of fermentation spoken of in this article, from their different characteristics, the alcoholic, the acetic, the alkaline, and the putrefactive states of fermentation; and as vegetable matters are composed chiefly of carbon, oxygen and hydrogen, with occasionally nitrogen, interspersed sometimes (as in woad, &c.) with foreign substances, this knowledge of the constitution of matters undergoing fermentation, and the chemical properties of their products, will enable us to comprehend what particular principles remain in the fermenting mass, at each and every stage of its progress, and what kind have been separated from it; it also explains the reason why, in some cases, the fermentation should commence with the first stage, or why it should, in other cases, commence at the second, third, or even the last stage, without having passed through the preceding ones."

"As the changes produced by fermentation can only be fresh arrangements of the above-named few principles, the proportions in which these exist in the mass will determine what state of fermentation shall first commence (though this is liable to some modification from the state of the atmosphere and other circumstances): —

"First. For instance, when the constituents are in the proportions of 4 carbon, 3 oxygen, 2 hydrogen, and 1 nitrogen, the fermentation will commence in the alcoholic state."

"Second. When the oxygen is in excess over the carbon, or when the proportions are 4 oxygen, 3 carbon, 2 hydrogen, and 1 nitrogen, then alcohol cannot be formed, because the excess of oxygen acidifies the product and gives rise to the acetic fermentation."

"Third. When the fermenting body contains little carbon or oxygen, compared with its hydrogen or nitrogen, — or reverse the proportions, and we have 4 hydrogen, 3 nitrogen, 2 carbon, and 2 oxygen, — in this case the greater proportion

of the constituents are such as compose ammonia and the alkaline fermentation must, of necessity, commence first."

"Fourth. And when the proportions are 4 nitrogen, 3 hydrogen, 2 oxygen, and 1 carbon, it is plain that the preponderating principles are all of an elastic character, and the least amount of electricity (or heat) goes to dissipate them in noxious vapors characteristic of putrefaction."

"When the constituents (or substances) are put together in the first-named proportions, the effect of the fermentation will be to carry off a portion of the carbon and oxygen, as carbonic acid, which will leave the remainder in the proportions that form alcohol: but as alcohol does not contain as much oxygen as acetic acid, it is evident that a re-action is necessary or an absorption of oxygen must take place by the alcohol before that can be converted into acid or exhibit acetic fermentation."

(Here we see the necessity of taking out the bungs from cider and wine barrels when we wish to make vinegar.)

"Acetic acid is nothing more or less than oxidized alcohol."

"In the third case, the effect of the alkaline fermentation is to carry off another portion of the carbon and oxygen (which are constituents in both alcohol and acetic acid), and leave the hydrogen and nitrogen to enter into combination as ammonia."

"And, lastly, on the evaporation of the ammonia, the remaining nitrogen, hydrogen, oxygen, and carbon (being a surplus of the constituents more than was necessary to form all the products of the other three species of fermentation), now form compounds with the phosphorus and sulphur (if there is any present in the fermenting article) and give rise to phosphoretted, sulphuretted, and carburetted hydrogen, and other nauseous and inflammable gases, that characterize the putrefactive process, which completes the separation of all combustible materials from the substance undergoing fer-

mentation; the operation is at an end and the disorganization of the substances completed."

"We have seen that the alcoholic, acetic, alkaline, and putrefactive kinds of fermentation, under certain circumstances, run, in succession, from the first to the last stage; every stage being distinctly separated and known from the other by the phenomena peculiar to it."

"And although all fermentation tends towards, and ultimately ends in the putrefactive process (unless it is checked), yet any of the stages of fermentation, by proper manipulations, can be caused to remain in that particular stage, and be preserved in that state as a separate species, and its further progress stopped."

"But it does not follow that, in order to produce any particular species of fermentation, we should go through the other stages that precede it; for although they are in some measure connected together, still they are each independent of the other; as the proportions of simple principles in the mass must be various to give rise to the different kinds of fermentation, and the putrefactive state can commence at once, without necessarily passing through any of the others; the alkaline can also begin without the least indication of there ever having been either acetic or alcoholic fermentation,—and the acid or acetic process can commence without any previous formation of alcohol. If we should commence with the alcoholic fermentation, we can carry the process through to its end, through the acetic, alkaline, and putrefactive stages; if we commence with the acetic, we can pass through the akaline and the putrefactive processes; and by beginning with the alkaline, we can continue it through the putrefactive. But if the putrid fermentation should commence first, none of the other stages can be elicited, because destruction has commenced at once, and all the combustible materials of the mass are separated, one from the other, and the whole is entirely dissipated."

"When fermentation has arrived at a certain stage, it may

progress towards its final consummation, but cannot retrograde in its action; therefore the alkaline state may pass into the putrefactive, but not back into the acetic or alcoholic stages, and the acetic may go through the alkaline and putrefactive processes, but cannot be brought back again to the alcoholic species of fermentation; the tendencies of every species of fermentation will aid it on until all the substances that compose the mass are driven off, and there is nothing left except such matters as are incapable of taking the aeriform state."

"This general description of fermentation, its different species or stages, and the mode of its operation, has been given for the purpose of enabling us to understand more clearly respecting the alkaline species of fermentation, or the operation of woad when in a blue-vat."

"It has been shown, in the description of couching or the curing of the woad, that it was brought by that process into such a state as to have a continual tendency to the production of ammonia, or into a substance whose fermentation commences in the alkaline stage."

"The soluble substances that are contained in woad, are mostly mucilaginous and extractive matter, albumen and a little saccharine matter; the albumen furnishes (independent of absorption from the atmosphere) the nitrogen which is necessary for the formation of ammonia, which it creates and evolves during its fermentation. The water in the vat being heated to 170° Fahr., and woad, madder, bran, lime and indigo now added, in the course of ten or fifteen hours afterwards, we perceive that a chemical change is taking place, by the appearance of the solution, which indicates that the operation of the materials has commenced."

"It is to ascertain what part each of the above materials performs, and what is the nature of the operation, which we must now consider. In the first place, the object in view is the solution of the indigo after the vat is put together; therefore, the indigo is the one to be operated upon by the other

ingredients of the vat. We have shown, in describing the setting and working of the woad-vat, that in order to effect the solution of the indigo, it was necessary first to bring it into a lower state of oxidation, and then an alkali must be present before the indigo would dissolve in water."

"The most important functions of the vat are to absorb oxygen and produce alkali; and as the proportions of the ultimate constituents of woad will be as four hydrogen, three nitrogen, two carbon, one oxygen (as in the alkaline stage), all in a free or uncombined state, and carbon having a stronger affinity for oxygen than for any other substance, hydrogen and nitrogen being also inclined to unite, the effect of these compound affinities will be to produce, simultaneously, carbonic acid and ammonia; but as the proportion of carbon exceeds the oxygen (in the woad), and the indigo, holding oxygen by a weaker affinity, gives it up to the carbon (creating carbonic acid), the indigo is deoxidized and will now dissolve in alkali; but as the ammonia and carbonic acid thus formed must, from their natures, reciprocally neutralize each other, and create a carbonate of ammonia, and as deoxidized indigo will not dissolve in the solution of a neutral salt, we must then in some manner destroy the carbonic acid before we can avail ourselves of the alkaline properties of the ammonia as a solvent of the indigo. To effect this object we add slack lime (ware) which will immediately unite with the carbonic acid, and then both are precipitated as an insoluble carbonate of lime, the ammonia is liberated, and the indigo will now dissolve in it."

"If we were to put nothing into the vat, except indigo and woad, it would, in time, assume its functions of deoxidizing and dissolving indigo; but in order to facilitate and give greater force or energy to the fermentation, bran and madder are added; as these substances furnish it with considerable saccharine and farinaceous matter, they may be considered as given for the same reason as yeast is added to a solution of sugar, in order to bring on the fermentation of the materials in all

their parts at once. Therefore when a woad-vat is first put together in the usual manner, the process commences with the alcoholic fermentation of the sweet matters in the madder, bran and woad, which deoxidizes the indigo, and forms carbonic acid; when, at the same time, the woad yields ammonia; but as this acid and alkali rapidly unite, and form a salt that will not dissolve indigo, and as at the commencement, the amount of carbonic acid formed is greater than the ammonia, a portion of lime is necessary to saturate the carbonic acid, then the ammonia becoming free, will now dissolve a portion of the deoxidized indigo. The process now proceeds as before; then, after a while, the carbonic acid will again obtain the ascendancy over the alkali; then another portion of lime is required to form ammonia, and some more indigo is then dissolved, so this alternate waiting for the formation of carbonic acid and serving with lime, is persevered in until the production of acid and alkali are balanced, and the whole indigo is brought into solution."

"If at any of these servings of lime we should give too large an amount of lime, or before the formation of any carbonic acid, we would then throw the vat back, and arrest the further progress of fermentation; in this case, we must give the vat madder and bran, in order to excite the fermentation, or else we must wait until the natural vigor of the woad will again promote fermentation; and, on the other hand, should we neglect to give the vat lime at the right time, then the carbonic acid will overpower the volitile alkali, and if allowed to proceed in this state, the ammoniacal odor will cease, the indigo precipitates, and the vat is in danger. But when the process of setting the vat has been properly conducted, and is fairly balanced, and all the indigo is brought into solution, then the operation of dyeing can be commenced."

"Yet, furthermore, as by dyeing in the vat, the liquor becomes exposed to the atmosphere, and in consequence, a quantity of oxygen is absorbed by the indigo, which imparts it to the carbon of the woad, giving rise to a quantity of carbonic

acid, that requires a portion of lime for its saturation; it is, therefore, necessary to serve with lime after every day's coloring."

"But should, we in serving daily with lime, overcharge it, the deoxidation of the indigo will cease, as the surcharge of ware prevents the formation of carbonic acid; the ammoniacal odor becomes more caustic; the liquor is darker colored; the bottom (that is, the woad) is blackened with the precipitated indigo, and feels heavier and tougher to rake up, and the color given by the vat is a gray, feeble-looking shade; the vat is now what dyers term full up with her ware, or is hard. If by repeated surcharges the vat has become so hard that it will not color, (and if it is carried to the greatest extent), all the indigo is precipitated; the ammonia has evaporated; the odor is that of recently slacked lime; the alkaline fermentation, and the production of carbonic acid, have ceased; and the bottom is black, solid, and tough. When a vat has got into such a condition, it requires a large amount of madder and bran to neutralize the excess of lime, in order to raise up the fermentation again. And, on the other hand, if by negligence in our daily serving the vat, we should leave it short of the necessary amount of lime required to saturate the daily production of carbonic acid in the vat, then the ammonia will be gradually overpowered; it will color wool a pale greenish-yellow, which will not become a distinct blue by exposure to the atmosphere. The odor of the liquor is at first soft and sweetish, then vapid and flat; the liquor and the sediment are greenish, or light colored, and are buoyant and loose. The vat in this condition, is in a critical situation, and must be served with ware as soon as possible, to prevent its passing suddenly into the putrefactive state of fermentation."

"Such are the explanations in regard to the phenomena of a woad-vat, and can be briefly summed up as follows:—

"First. That the intention in using woad, madder, bran, and lime, in a vat, is to effect the solution of the indigo in water."

"Second. That the madder and bran act as a ferment, and excite fermentation."

"Third. That the fermentation of woad is a double operation, producing carbonic acid and ammonia, which, uniting, form carbonate of ammonia; while, as carbonic acid forms, the indigo is deoxidized."

"Fourth. That the lime decomposes the carbonate of ammonia, precipitating the carbonic acid, and leaving the ammonia free, when the deoxidized indigo is dissolved in it."

"As the formation of carbonic acid is necessary to the deoxidation of the indigo, and the presence of ammonia is required for its solution, it is indispensable to precipitate the former, in order to give freedom to the latter; hence, the important part that lime performs in effecting this object, constitutes it the nice balancer of the vat, and the great regulator of the fermentation. And the exactness required in proportioning the lime to the amount of carbonic acid formed, is what makes it the most delicate and difficult operation in the whole art of dyeing; for the principal derangement of a woad-vat, proceeds from either an overcharge or undercharge of lime."

"The amount of lime given, must be in such a proportion to the amount of carbonic acid formed, that the two substances will mutually saturate each other, and thus form a neutral insoluble precipitate of carbonate of lime, leaving the ammonia and indigo in solution. This situation of the vat constitutes its true or correct working condition."

TANNIN.

The word or term *tannin*, was originally applied to a principle contained or existing in many vegetables. This principle has a very astringent taste, and has the property of producing a white flocculent precipitate, with a solution of

gelatine, and a black precipitate with the salts of sesquioxide of iron (Fe_2O_3). As obtained from different plants, it was found to have some difference in properties, for which reason chemists recognize two kinds of tannin, one existing in oak bark, galls, &c., this kind being distinguished from the other kind, by its producing a bluish-black precipitate with the sesquioxide of iron. The other kind of tannin existing in Peruvian bark, catechu, &c., is distinguished by producing a greenish-black, or a dark olive precipitate, with the above salt. The former kind has received the most attention from chemists, and from their examinations the characters of tannin have generally been given. The tannin derived from galls, has the peculiarity of being converted into gallic acid ($C_{14}H_{16}O_{10}$), which property is wanting in the tannin obtained from catechu or Peruvian bark.

Since the experiments of M. Pelouze in relation to tannin, it has been universally admitted to rank with the acids, and is now, therefore, termed tannic acid ($C_{18}H_5O_9+3HO$). The tannic acid obtained from galls, has been termed, for the sake of distinction, by some chemists, *gallotannic acid*, and by others, *quercitannic acid*. (See article, Tannic Acid).

Tannin has a strong affinity for, and intimately combines with, vegetable fibre, and also with color and its constituents, and therefore it serves as the medium of combination; and as the greater part of nutgalls is made up of tannin, we see the important part that galls play in the operation of dyeing those substances that have only a very feeble affinity for colors. But as nutgalls contain gallic acid in large quantities (which would be useless as an *intermedia* in coloring operations), we would very naturally suppose that a substance which contains more tannin and less gallic acid than galls appear to, would answer the purpose of an *intermedia* much better than galls; and there is not the least doubt in my mind, but that catechu (which is one-half tannin) would do better for that purpose, on some colors, than nutgalls.

Tannin does not crystallize, but forms by precipitation or

evaporation, a brown, resinous-looking substance, which will readily dissolve in water. This vitreous form serves to distinguish tannin, or the astringent principle, from the true or real coloring-principle of dyestuffs, the latter principle being a crystallizable body. Although tannin exists more or less in nearly all the common dyestuffs, for all that, it is a distinct principle from that which is the immediate cause of color in dyeing operations. Yet it is our opinion, that the tannin contained in dyestuffs is the radical of the coloring-principle; or, at least, we think that the former (tannin), either by absorbing more oxygen, or from a change in the amount of its carbon, or by a combination of both, becomes the coloring-principle in a measure. However, as there is no positive proof of such a connection, we shall view them as two distinct substances, and endeavor to point out the peculiar features that distinguish one from the other.

Tannin, when separated from every other substance, and when pure and dry, appears as a brown-colored, brittle, and resinous substance, and it is uncrystallizable. The coloring-principle, when it is separated from every other body, is generally in a mass of crystals, and possesses the power of precipitating all the metallic oxides from their solutions (of producing well-defined colors), which tannin does not. The two principles can be separated one from the other by adding gelatine, which will precipitate the tannin and leave the coloring-principle in solution.

Tannin will aid in filling up, or giving body to some dark colors, by the amount of dun or tawny matter which it communicates; but for light or very bright colors, it should be separated from the coloring-principle by means of gelatine, as the most brilliant hues are obtained only by the true coloring-principle of the dyestuffs which we have to use.

Many of the dyestuffs we use contain tannin. Catechu contains nearly fifty per cent., nutgalls thirty to forty-five per cent., sumac seventeen per cent., quercitron-bark six per cent., or very nearly the above proportions. The action of

tannin upon the mordants is very often injurious to the tint or hue we wish to obtain. The dyewood being boiled to extract the coloring-matter, the tannin contained in the wood is dissolved, and it is sure to act upon the mordant, which is combined with the fabric to be dyed, when we come to immerse it in the coloring-solution, producing an effect upon the fabric very similar to that of adding a little sumac to the coloring-matter. In many cases this would be beneficial, but in other cases it would be injurious.

In silk, but more especially in cotton dyeing, tannin or astringent matters are more necessary, and are more extensively used than they are in woolen-dyeing, because the silk and cotton, not having so powerful an affinity for colors as wool has, it is necessary to impregnate these substances with some substance that will have a tendency to unite the color with the silk or cotton, and this substance is called tannin, or the astringent principle; therefore, the silk and cotton dyer endeavors to use those substances that contain more or less of this principle in their operations, as it serves as the *bond* of union, or the *medium* of combination, that could scarcely have been effected without it; therefore, those dyestuffs that contain astringent or tannin matter, in the case of silk and cotton dyeing, act a very important part in dyeing those substances.

Vegetable Substances used in Dyeing that Contain Tannin.

The following vegetable substances — quercitron-bark, sumac, divi divi, nutgalls, valonia-nuts, and catechu, or cutch — contain essentially an astringent principle, termed *tannin*, or *tannic acid*, which, although it differs in some of its properties as derived from different plants, yet agrees in all cases as being of an astringent taste, and giving acid re-action to test-paper, and of yielding, with the salts of iron, a deep blue-black or green-black color, and it will precipitate a solution of glue and cinchanine.

Quercitron-bark contains, according to E. Wolff, from 10.86 to 15.83 per cent. of tannin, or tannic acid. This variation he explains by giving the age of the tree, and the part of the bark taken for analysis, thus:—

	Tannin.	Age of the trees.
In the crude bark covered with the rind,	10.86 per cent.	41 to 53
inside layer of the old bark, . .	14.43 "	41 to 53
inside of the bark, ...	13.23 "	41 to 53
crude bark, and inside of bark, .	11.69 "	41 to 53
inside layer, and inside of bark, .	13.92 "	41 to 53
inside of bark, ...	13.95 "	14 to 15
inside of bark, ...	15.83 "	2 to 7

The above is at variance with the researches of Buchner (1867), who asserts that the very best of black-oak bark (quercitron-bark), does not exceed, in amount of tannin, over 7 per cent. Dr. Wagner found only 7.3 per cent.

Sumac takes its place next to quercitron-bark as regards the small amount of tannin contained in it; but the quantity varies (according to the country in which it was grown) from 12 to 17 per cent.

Divi divi, or *Libi Davi.* This coloring-substance contains, according to Muller, 49 per cent.; by Fleck, 32.4 per cent., while Dr. Wagner found from 19 to 26.7 per cent.

Nutgalls. Those from Aleppo contain from 60 to 66, according to Fehling; while Fleck found 58.71 per cent. of tannin in the same galls, besides 5.9 per cent. of gallic acid.

Valonia-nuts contain from 40 to 45 per cent. of tannin; but when these nuts are ground to a powder, they seem to leave nearly one-half of their tannin-property, as they, in this state, contain only from 19 to 27 per cent. of tannin, according to Rothe's analysis.

Catechu, or cutch, contains more tannin than any of the above-named substances, having from 45 to 62 per cent. of

it. No two samples of catechu will give the same quantity. This coloring material is used to the same extent in cotton-dyeing as are nutgalls; but it is seldom used in woolen-dyeing.

There are other coloring substances that contain tannin, but the quantity is so small that we will omit any remarks upon them.

AURANTINE.

This is another of the yellow coloring-substances which is now becoming extensively used in the coloring of wool and cotton. The process for its manufacture is, we believe, kept a secret; the same can be said of flavine. It was first introduced in 1871, and although of so recent introduction, for cotton and wool coloring, it is being very largely used by cotton and woolen dyers, also by calico-printers, and has almost entirely superseded the use of Persian-berries, flavine, and quercitron-bark in calico-printing.

On cotton or wool it will produce a color from the most delicate lemon-shade to a rich, full, and deep yellow. It is well adapted for coloring scarlets, used along with cochineal, on wool or woolen fabrics; also for scarlets on cotton, when used along with saffranine,—superseding the so-called *aniline* scarlet dyes. It has double the coloring-powers of flavine.

The mordants used are mostly the same as for flavine. It produces beautiful shades of yellow on raw cotton, when colored in the lap, by the use of alum alone as a mordant.

A solution of aurantine gives the following precipitates with the following metallic salts:—

Oxy-muriate of antimony gives a very bright canary-color.
Oxalic acid gives a very bright but light yellow.
Sulphate of iron gives a dark sage-drab color.
Sulphate of copper gives a bright, light sage color.

Tin crystals give an orange-yellow color, rather dull-looking.

Tartaric acid gives a very light sage color.

Sulphate of alumina gives a rich-looking yellow, not so bright as oxalic acid, but deeper.

We see by the different re-actions of the above salts, that they give a better result with aurantine than with flavine, which cannot be accounted for in any other manner than by the greater amount of coloring-principle contained in the aurantine than there is in flavine.

Aurantine is very rich in coloring-matter. Boiling-water extracts some tannin from it, and when it is evaporated, it leaves a resinous, light, cinnamon-colored substance, weighting less than one-tenth the weight used for the experiment.

This tannin, however, is principally extractive matter, and the coloring-principle of the aurantine; and if we would precipitate the small amount of tannin there is in it, by using one pound of glue to every pound of aurantine used, we will obtain a much brighter yellow.

For the brightest shades of canary-color, the oxy-muriate of antimony seems to be the best and proper mordant for wool colored yellow with aurantine. If we wish to obtain a yellow of a lemon shade, we must use for the mordant *sulpho-muriate of tin* (see Solutions of Tin); and for a yellow of an orange shade, use *murio-sulphate of tin;* and for a yellow called brimstone-color, use *sulphate of tin*, with the same weight of tartar that there is of sulphate of tin, with a very little alum.

The orange-colored yellow can also be obtained by using a very small quantity of cochineal with the aurantine; that is, when using oxy-muriate of antimony as a mordant; but should you use muriate of tin as a mordant, instead of the oxy-muriate of antimony, the color will not be as bright and lively.

The lemon shade can also be obtained by using a *very small*

quantity of sulphate of indigo along with the sulpho-muriate of tin and aurantine; yet it is better to give the particular shade by a variation of the mordants.

How aurantine would work for giving the yellow part of color to browns, olives, and greens, I am not able to state definitely at present, but think it would do vastly better than either quercitron-bark, flavine, or even fustic, on account of its concentrated strength of color and brightness.

Henry D. Dupee is sole manufacturer of aurantine and oxymuriate of antimony, 79 Kilby Street, Boston, Mass. (See articles Flavine, Fustic, and Quercitron-Bark.)

BLUE–VATS.

Woolen and cotton fabrics, or tissues, are dyed indigo-blue by means of reducing indigo in an alkaline fluid, the material being blued by exposure to the atmosphere; or, in other words, they become blue by the oxidation of the indigo taken up by the fibre, the dye becoming simultaneously fixed. The principle of this method of coloring with indigo is known as blue-vat dyeing. The same kind of blue-vat is not adapted for both cotton and wool, as will be seen by the following details of the different blue-vats now in use both in America and Europe. The lime and copperas vat is not adapted for dyeing wool; neither is the woad-vat adapted for coloring cotton. Therefore, it will be seen that there must be a wide difference in the composition of the two vats. The copperas-vat for cotton-yarn and cloth is set (a technical term for preparing a vat to color in) with lime, copperas, ground indigo, and water, the proportions differing with different dyers, but the most common proportions used being as follows: Nine hundred gallons of water; sixty pounds of green copperas; thirty-six pounds of ground indigo; eighty-five to ninety pounds of slacked lime; or the same proportions according to size of

vat. These materials are stirred or raked up every half-hour for three or four hours; then left for twelve hours, and then raked again; and after it has settled, the vat is ready to color in.

The chemical action, in the first instance, consists in the formation of sulphate of lime (SO_4Ca — gypsum), and protoxide of iron (FeO). This latter substance having a great affinity for oxygen, removes an atom of it from the blue indigo, which converts the blue indigo into white indigo, which dissolves in the excess of lime, and is now ready to color in.

When the ground indigo is put into a vat, the composition of which is lime and copperas, the first action which takes place will be the decomposition of the copperas; the sulphuric acid, which is in combination with the iron, combines with a portion of the lime, forming sulphate of lime and oxide of iron. "The detached oxide of iron extracts more oxygen from the indigo, converting it into indigogen (or white indigo); and the peroxide of iron, and sulphate of lime thus formed, are precipitated, forming what is technically known as *sludge*. The remaining portion of lime dissolves the indigogen, and forms with it the solution required."

The following is a representation of the action and result, and gives a clear view of the blue-vat: —

"Indigo, composed of	Indigogen, dyeing-solution. Oxygen, peroxide of iron.
Two copperas, . .	Oxide of iron, peroxide of iron. Oxide of iron, peroxide of iron. Sulphuric acid, sulphate of lime. Sulphuric acid, sulphate of lime.
Three lime, . .	Lime, dyeing-solution. Lime, sulphate of lime. Lime, sulphate of lime."

It will be seen by the above diagram, that this theory of the

copperas-vat is founded on the blue indigo ($C_{16}H_{10}N_2$) being an oxide.

The view which Dumas takes of the constitution of indigo, and the action which is said to take place in the vat, will be somewhat different from the theory given above. "When the lime combines with the acid of the copperas, the iron decomposes a portion of the water, combining with the oxygen, and the hydrogen combines with the indigo, forming indigogen" ($C_{16}H_{10}N_2O_3$), which Dumas represents as follows: —

"Indigo, .	Indigo, indigogen forming the dyeing-solution.
Water, . .	Hydrogen, indigogen forming the dyeing-solution. Oxygen.
Three lime, .	Lime, peroxide of iron. Lime, sulphate of lime. Lime, sulphate of lime.
Two copperas,	Oxide of iron, peroxide of iron, Oxide of iron, peroxide of iron. Sulphuric acid, sulphate of lime. Sulphuric acid, sulphate of lime."

This theory is equally if not more correct than the former one, but in many cases it is hardly reconcilable with our experience, chemically speaking.

According to the former theory, the indigogen combines with the oxygen, for which we know it has a very strong affinity, forming blue-indigo, which will remain combined with the fabric; but, in accordance with the latter theory, the blue-indigo will be left in combination with the fabric or yarn by the hydrogen combining with the oxygen of the air, and thus forming water.

If a quantity of lime and copperas is put into a bottle of distilled water, we find that the water will not become decomposed, because the lime will combine with the acid in the cop-

peras, and will, along with the iron, precipitate; should you exclude the air completely from the mixture, by corking the bottle tightly, the iron will remain in the bottle as a protoxide, for many days; the change from a protoxide to a peroxide is so very slow that some time will elapse before it is perceptible; but should you add indigo to it after this mixture has stood for some days, the action of the common vat will occur. This, in accordance with Dumas's theory, gives a good illustration of relative affinities.

Before the indigo was added, the attraction of the copperas for oxygen would be nearly equal to that of the hydrogen, which holds the oxygen in combination as water; but when the indigo is added, although the indigo has a very weak attraction for hydrogen, because it requires the nicest management to get the hydrogen isolated, yet it is sufficient to disturb the equilibrium with which the oxygen is held by the iron and hydrogen, giving the oxygen the mastery.

Whether an alkaline substance has any effect in producing the formation of indigogen, we do not pretend to say, but it is never formed in the vat without the presence of an alkaline substance to dissolve it the moment it is formed. There is one serious trouble in working the copperas-vat, which consists in what is called *swimming;* that is, the vat does not settle. This is caused by a number of circumstances, — one cause is that the copperas contains too much acid, which forms a sulphate of lime, causing it not to settle so quickly, the copperas not being decomposed; but the principal cause of a floating-vat is that there is too much lime and copperas in proportion to the indigo; to remedy this there must be more indigo added to the vat, so as to peroxidize the copperas. Another cause for its floating is that the lime has been too long slacked, and, being exposed to the atmosphere, it becomes converted into chalk; and when such lime is used it is very injurious in other respects, besides causing swimming or floating. The lime used should be freshly slacked to produce the best effects in a copperas-vat.

The following are the proportions of materials used in the vats for skein-dyeing (the vats being usually wine-casks), assuming that the materials are of the best kind: eight pounds of indigo, fourteen pounds of copperas, eighteen pounds of lime; these materials being put in, the whole is raked every two hours through the day; on the following morning it is ready for use.

The proportion, or equivalent, of lime can be calculated from the table of elements (which see), and also the rate of combination. The technical term for slacked lime being hydrated oxide of calcium (formula, CaO,HO), and the equivalent of lime being 20; oxygen, 8; hydrogen, 1; and oxygen, 8; or thus: —

$$\begin{array}{ll} \text{Lime, ...} & \left\{\begin{array}{l} Ca=20 \\ O=\ 8 \end{array}\right. \\ \text{Water, ...} & \left\{\begin{array}{l} H=\ 1 \\ O=\ 8 \end{array}\right. \\ & \overline{\quad 37} \end{array}$$

The copperas being thus expressed: —

$$\begin{array}{ll} \text{Copperas, ...} & \left\{\begin{array}{l} Fe=28 \\ SO_4=48 \end{array}\right. \\ \text{Water of crystallization . .} & 7\,H_2O=63 \\ & \overline{\quad 139} \end{array}$$

By this we find that the slacked, or hydrated lime has thirty-seven equivalents, and should neutralize one hundred and thirty-nine equivalents of copperas; or we will say that thirty-seven pounds of lime should neutralize one hundred and thirty-nine pounds of copperas; but as we find that seventy-seven gallons of water, at 60° Fahr., will dissolve but one pound of lime, it is easy to see what a few pounds is required above the equivalent for copperas to form the lime-solution of the copperas-vat. These vats are always worked cold.

Messrs. R. Schloesser & Co., of Manchester, Eng., have made a very marked improvement, within the last three or four years, in the method of setting the copperas-vat, which has removed the bulky sediment of lime which was such an objection to the vat; besides, this improvement saves a great loss of indigo by its combination with the oxide of iron; the solution is much clearer, the cotton pieces are not apt to be so spotted (as when colored in the usual way of setting a copperas-vat), and a better class of work is obtained.

"To carry out their process, they add to the ordinary two thousand-gallon vat twenty pounds of ground indigo, thirty pounds of iron-turnings, thirty pounds of powdered zinc, and thirty-five pounds of quicklime; the whole is raked up from time to time, for twenty-four hours, when it is ready for use." If the vat is not considered strong enough, they add more lime and zinc. The chemical theory of the process is, that the zinc, under the influence of the lime, decomposes the water, combining with its oxygen; and the hydrogen, thus liberated, removes oxygen from the indigo, which will then dissolve in the lime.

WOAD-VAT.

The vats for coloring wool indigo-blue, are known by the name of woad-vat, pastel-vat, potash or ash vat, and the German-vat; besides others inserted in this work. The woad-vat gives the best results of any kind of a blue-vat yet known, although it is the most difficult to manage of any. It requires an experienced dyer to work one economically and for the profit of his employer, and no dyer but an experienced one should attempt to, or be allowed to manage a woad-vat; for without considerable practical experience, very close observation, and a thorough knowledge of the effects produced upon the vat, by each of the different materials used in the

process of working one, no dyer can work one without a great risk of losing it.

The manner of setting and conducting a woad-vat we have abridged from "Gibson's System and Science of Colors," which we consider the best method adopted among the very many methods now in practice. "This slight description of a woad-vat, is not to stimulate the inexperienced to attempt the management of so difficult and inexplicable a part of dyeing, but only to give a general outline of the common or usual manner of setting and conducting a woad-vat, so that those who have had no opportunity of observing the process, can form some idea respecting the manner of working one."

Dimensions of vat, seven feet deep and six feet diameter. "Fill this up to within about two feet; then throw in five hundred pounds of woad well chopped up into small pieces; let this soak overnight, the water being heated to about 180° or 190° Fahr.; rake up well the next morning; fill up the vat to within six inches of the top, and heat it to 175°; then put in ten pounds best madder, twenty quarts of wheat bran, forty pounds Bengal indigo, ten pounds of slacked lime (technically called ware); rake these up for half an hour; then put on the covers to the vat; then in the afternoon rake up again and leave for the night." "Be at the vat early next morning; uncover the vat and see if there are not some bubbles standing upon the surface; take some of them up with your fingers and you will find that they have more consistency and are tougher than bubbles formed by clear water. Next look the surface over, and see if there is not a thin film of indigo, of a purplish shade upon it, which can be taken up on the finger-nail; then agitate the liquor with a small stick a little; take out the stick and incline it, and plunge two or three inches beneath the surface, agitating briskly, so as to raise a number of bubbles; take some of them up between your fingers, part the fingers, and then see if they stand full and do not break quite so quick as bubbles formed by water." "Now take the dish and dip up some of the liquor, and let it

run gently over the side of the dish into the vat, and while it is so doing look through it towards the light, and it should appear of a deep green or olive color." "Having gone through with this examination, and found that the vat exhibits these features, it shows that the vat has sprung its indigo, or that some of the indigo is in solution, or, in other words, a portion of the indigo has become deoxidized by the fermentation of the woad, madder and bran, and is now in want of some alkaline matter,—give it five pounds of lime (*ware*) and rake it up gently, but well, avoiding plunging or too much agitation; cover it up and let it stand for two hours; then look at it again, and suspend a lock of wool in it for ten or fifteen minutes. This should come out a yellowish-green, and will take five minutes before it will become entirely blue (or ungreen, as dyers say)." "Lay this lock aside so as to compare with the sample that you may try the next time you examine the vat." "In about one hour examine the vat again, and there should be a greater quantity of bubbles formed, and a *flurree* has formed, which lies well to the back part of the vat. The liquor looks richer in color, the scum or pellicle of indigo has become thicker and more copper-colored, and on moving the liquor with your hand, or with the dish, green waves or rather veins, can be seen."

"The vat is now opening. Examine it with the dish as before, and the liquor you will see has become a still more yellow-green or olive color, showing a further deoxidation of the indigo, and now it wants more ware. Give it five pounds of ware; rake up as before." "Let it stand for three hours; then suspend a second lock of wool in it for ten or fifteen minutes; when it is taken out it should be of a deeper shade, and more like a grass-green than the first lock was; it will take a longer time for it to *ungreen*, and will be almost a middle-blue, with a slight green tinge, after being exposed to the atmosphere for half an hour." "Now compare this with the first lock, and it should be a deeper and clearer blue than

the first. This shows that the vat is progressing well, but is short of ware."

"A slight observation of the smooth part of the vat convinces you of its improved condition, the scum or pellicle looks richer and more glossy, and on blowing upon it with your mouth, you will see the scum of indigo open in a circle, showing the liquor beneath it of a yellowish-green, and the circle will close again on withdrawing your breath." "Waving the surface about with the dish, the veins or wavy shades of color are of a livelier and yellower green than in the former examination; they spread wider and seem to roll about much longer, and the color strikes the hand quicker and deeper."

"The *flurree* is now much more in quantity, and looms up well on the back part of the vat, covering more space than before, the bubbles are larger, and are of a fine indigo-blue. If the vat has these characteristics, give it five pounds more of *ware*, rake it up, and let it stand four hours. After it has rested for this length of time, dip in another lock of wool for twenty or thirty minutes, and when it is taken out it should be a deep, rich green, and in about five minutes, change to a lively, even, middle blue, having a slight tinge of purple to it."

"If this green should pass to a pale grayish-looking blue, the vat has got too much *ware*, or is hard; but if it retains the greenish shade after being out and exposed to the air for twenty minutes, it is a certain criterion that the vat has not *ware* enough, or the vat is soft, and needs a little more *ware*." "Blow strongly upon the surface of the vat, and a circle of one or two inches in diameter will appear, showing the internal liquor of a fine gold color, or in some cases a rich yellowish-green." "The bubbles and *flurree* are more numerous, and of various sizes, some of them being as large as hen's-eggs, and are a beautiful indigo color; they stand well, and do not easily break or fall down, even when strongly agitated."

"On waving the clear surface from side to side, with the dish, the scum or pellicle of indigo runs off towards the

flurree, and shows all the indigo shades, from the lightest blue to the richest purple; the wavy veins are now larger, wider, and roll about more than before, the body of the liquor being of a rich yellow, intermixed with the various shades of green. On examining the liquor with the dish, you will see that it looks well, and has a good strong body, and on turning the dish, with the edge towards you in a perpendicular manner, the liquor hangs from the edge like a fine syrup, and gives a fragrant and agreeable smell, not unlike weak ammonia."

"Take it as a whole, and the vat presents a splendid appearance, and everything about it shows that it has got its full complement of *ware*, and is now ready to color in."

"There are cases where a vat sometimes requires more and sometimes less lime than has been mentioned; this is owing to the variation in the strength of the woad and the quality of the lime; but, as a general rule, five hundred pounds of woad will require from twenty-five to thirty pounds of *ware*." The vat should be kept up to 135° of heat during all this time.

"By taking the above plan, and assuming that the materials are of the best quality, all these changes and appearances will take place, and the progress of the vat will be as certain as the above short description has represented it to be, so much so that in nineteen cases out of twenty it will be brought to work on the day after it is set, and can be colored in on the following day."

The Manner of Working a Woad-Vat from Day to Day.

Gibson's System of Dyeing.

"A vat of the size specified in the preceding pages will color from fifty to seventy-five pounds of clean wool at a time. Shake this amount of wool into small locks in front of the vat, taking care to have it opened well, so that the whole pile may be loose; this is done in order that the color will strike the wool evenly and all alike. Now uncover the vat, and skim off the *flurree* into a pail, and after coloring, when ready

to rake up, turn this *flurree* back into the vat again. Put in the trammel and net, then throw in the wool lightly and expeditiously, getting it under the liquor as soon as possible. Handle the wool with the sticks until the whole is even, and continue the stirring for about half an hour. Now take it out, having it well wrung out, throw it upon the floor, and shake it over, so that it may ungreen as speedily as possible."

"If you have an old or a weak vat, you can dip the wool in that to finish it; but if not, then take the sample you have to color by, and compare it with that which you have just dipped, and see if you can bring up the shade required, by giving it another dip, without having to rake the vat. If you find you cannot, then have it well raked up, and after it has become settled, enter the wool again, and proceed as before; but do not allow it to stay in any longer than it requires to bring up the color to the desired shade."

"When it is taken out proceed as before, and when it is ungreened have the wool well washed off."

"Now give the vat five pounds of ware, rake up well, and if the heat is low put on steam until it rises to 135°, then cover up the vat," 135° being the best temperature to work the vat.

"Let all these operations be concluded by three or four o'clock in the afternoon, so as to give the vat time to rest and clear itself before the last raking time,* and by this means it will give you an opportunity of judging of the precise state of the vat—whether it is in want of *ware*, or has got too much of it."

"After raking, heat up to 135°. About seven o'clock, P. M., go to the vat and examine the liquor; see if it looks clear and

* This used to be at eight o'clock, P. M., but now dyers do not go to their vats after they have done their day's work until the next morning; so if their vats are not in good condition, they have either to rake them before they can color in them, or color in them and get a poor color; when, if they looked at the vat in the evening, and it wanted raking or serving, they could then do it, thus saving time the next day, besides having a vat in condition to color in, and not be obliged to color in it when out of order.

hangs well to the dish; notice whether it has a good *flurree,* and the smooth surface looks glossy, and on blowing into it, it opens and closes up again, showing a copper-colored pellicle, as was described in regard to bringing the vat to work."

"Smell at the edge of the dish; if the vat has too much *ware,* it will smell of the lime; if it has not enough lime it will smell vapid and soft; in the latter case give the vat three pounds of *ware;* but if it smells of the lime, give four or five pounds of madder and six or eight quarts of bran, and rake up well."

"The next day proceed to color with the same weight of wool in the same manner, and give, after coloring, from three to five pounds *ware,* which will be about the amount required for each day's coloring afterwards, with few exceptions. After three or four days' work you will have to renew the vat with indigo; this should be done after coloring in the afternoon; give it as much indigo as your judgment directs; that is, as much as you think the wool has taken out, and at the same time give five pounds of madder, two quarts of bran, and four pounds of *ware,* as the case may be; then rake up well."

"Perhaps a good raking may answer, without giving it either lime or madder; but your judgment must determine this according to the appearance of the vat."

"In giving or serving the vat with indigo, there is no particular stated period for doing this, as some dyers give the vat indigo every day; others, every two days, and some but once a week, each having his own particular opinions or ideas in regard to serving with indigo; but we think that a vat should receive a renewal of indigo twice a week; that is, every Wednesday and Saturday afternoon." The vats should be raked and looked to, at least once on the Sunday, if you intend to work them on the following Monday. A vat does not pay to work over four months before re-setting, that is, if you work it every day, as after that length of time it requires a larger amount of indigo to produce the same shade than it would if it had been worked but two or three months.

"In the above description the reader has only been conducted through the process of setting and working a vat upon the most scientific principles, and where everything has gone on in a straightforward manner and with the most perfect success, because we have had the best materials to work with (which ought always to be the case), and have been treating it in a workmanlike manner, knowing beforehand the nature and proper application of the materials we were using, and the certain effects of everything we employed."

"The reader will be satisfied that a short description of this kind upon the most important and complicated department of dyeing, is of more real value than a volume of observations on the methods of getting a vat right after suffering it, by an injudicious mode of treatment, to get wrong."

"It is easy to perceive that there could be more written respecting the woad-vat; for there are numberless appearances of the vat and wool, which, if closely observed by the dyer, will give him a certain knowledge of the precise state of the vat, and will point out to him the materials it is most in want off; these have not been noticed."

The want of success in working a woad-vat is often caused by using poor woad and poor indigo. (See articles, Woad and Indigo.) Indigo is a substance which contains from thirty-five to seventy-five per cent. of true indigo. So with such a wide range, to say nothing in regard to the difference in quality that there is in indigo, it is not surprising that some of our best dyers sometimes err in their judgment in regard to the state of their vats, and are often troubled to ascertain the cause of the vat working so imperfectly or irregularly. Limes that are used should be considered also. Most of the American limes contain a large amount of magnesia, or at least they are always mixed more or less with magnesia, and when lime contains magnesia and is used for blue-vats, it forms into sulphate of magnesia (MgO,SO_4), which is very soluble, and by successive additions of such lime, causes the specific gravity of the liquid of the vat to increase to a point when the woad and

madder will with great difficulty settle, so that it will be fit to color in. It is better to employ these limes that are free from magnesia, which are those burned in Thomaston and Rockland, Me.

PASTEL-VAT.

In setting all blue-vats, with the exception of the copperas-vat, the first thought and care of the dyer should be to employ those substances that are capable of combining with oxygen, directly or indirectly, and are also capable of imparting hydrogen to the indigo. These substances are, pastel, woad, madder, and weld. Madder, when brought into contact with an alkali, gives a violet tint, and by the addition of indigo, it gives a still deeper shade. The weld is richer in oxidizable principles than either pastel or woad; it turns sour and very soon passes into putrefactive fermentation. A great number of dyers in Europe use weld very freely, but the others who use it at all in these vats, employ the same amount of it that they do of bran, and others do not use it at all.

The size of a pastel-vat, as a general rule, is the same as a woad-vat; that is, seven feet deep and six feet in diameter. This is filled with water to within one foot of the top, and heated to 180° Fahr., the materials being 300 lbs. pastel, 20 lbs. madder, 12 lbs. bran, 9 lbs. lime (ware), and 40 lbs. indigo.

The pastel being very dry and hard, is first pounded to pieces (some dyers maintain that the pounding of the pastel is injurious, and this opinion deserves attention), and then thrown into the vat along with the madder and bran, then raked up for half an hour; in the course of two or three hours it is again raked, and the nine pounds of ware added, so as to form a sort of alkaline lye, which will hold the indigo in solution. After the above raking, and the adding of the lime, it is allowed to rest four or five hours. After this length of

time has elapsed, it is raked again, and you will find that it has the peculiar odor of the pastel, and its color is a yellowish-brown. In twenty-four hours from this raking, the fermentive process will be observable; the liquid will have an ammoniacal odor, yet at the same time you will distinguish the odor of the pastel, and the color will be a yellowish-red; the flurree has commenced to collect at the farther side of the vat; a brilliant pellicle covers the smooth surface of the vat, having a greasy appearance. Underneath this, you will also see blue or almost black veins, which are owing to some particles of indigo contained in the pastel naturally. If you should now take some of the liquid and turn it upon a piece of glass, you would see the yellow color disappear, and the blue of the indigo take its place. This, we all know, is caused by the absorption of oxygen from the atmosphere, by the little indigogen in the pastel. If all these appearance occur, they are a sure criterion that the fermentation is properly established, and that the vat is now ready for its indigo, and that there is enough hydrogen formed to dissolve the indigo. We now add the forty pounds of indigo (sixty pounds if for very full blues); it is now thoroughly raked up, and if the temperature is below 130°, turn on the steam until it reaches that temperature, at which heat keep it during all the time that you may work it. Add with the indigo, seven pounds of ware, and after raking and heating up, if needed, as above, cover it up and let it rest for three or four hours. After this time has elapsed, look at the vat and see if there is not a large amount of flurree and a copper-colored pellicle covering the smooth surface of the liquid (the same as with the woad-vat). The dark veins are larger than they were previously, and the liquid is of a deep yellow-red color, and will have an emerald-green color, as you turn some of it from the dish back into the vat. The odor of the vat will perhaps have a vapid smell; if so, give five pounds of ware, and rake up; but if it has an ammoniacal odor, it is to be raked only. After the vat is settled, it should be ready to work.

For further instructions in regard to the manner of working it from day to day, see article, Woad-vat, as there is but little, if any difference in the phenomena of a pastel-vat from that of a woad-vat. There is, however, a great difference in the color of the wool from the two vats, in this particular point — the temperature of the pastel-vat requires a very uniform heat, for if it is too hot, the wool will have a red tinge (but not so with the woad-vat), and it will cause the pastel to ferment very rapidly.

Woad and pastel vats are very prone to run to the putrefactive state of fermentation, which is owing mostly to the nitrogenous matters contained in the woad and pastel, they of themselves being vegetable, for which reason they require greater care and skill in their management.

Indigo, if exposed to putrid fermentation, is decomposed, and loses its blue color; if rendered soluble, it will obey the impulse communicated to the nitrogenous matters with which it is brought into contact, although indigo, if macerated in water at its common temperature, is with great difficulty decomposed. If fermentation is allowed to continue unchecked, the solution will turn to a yellow color, the flurree becomes white, it will smell stale and lose all its ammoniacal odor, and in a very few days the color is whitish, and the smell is at first like putrefied flesh, then not unlike the odor of rotten eggs, and free sulphuretted hydrogen. The use of lime in the woad and pastel vats, is to prevent such an occurrence, as well as for neutralizing the carbonic acid created by fermentation.

There are some dyers who set a pastel-vat as follows:—

The vat is filled with water, and then heated to the boiling-point. There is then thrown in 400 lbs. pastel (previously pounded up), 22 lbs. madder, 17 lbs. weld, 13 lbs. bran, and it is then boiled for half an hour, after which there is added sufficient cold water to reduce the temperature to 130°; it is then raked up for an hour, the vat is then covered up and

allowed to rest for six hours; after this time has elapsed, it is again raked for half an hour; this raking is repeated every three hours until the surface of the vat shows blue veins; there is then added eight pounds of slacked lime (ware).

The color of the vat now assumes a blackish-blue, and then the indigo is added to it; the amount of which is in proportion to the depth of shade required, as follows:—

11 to 13 lbs. for 100 lbs. of fine wool for a medium blue.
30 to 40 lbs. for 100 lbs. fine wool for a full blue.

The dyér who communicated to me the above method, says that the following are the characteristics of the vat: The color of the vat is a fine golden-yellow, its surface having a blue flurree and a copper-colored pellicle; on agitating it, there will be bubbles of air escape, which should burst very slowly; if quickly, it wants more ware. The sediment at the bottom will be green when first drawn up, and should turn a brown color in the air; if it should remain green, it shows the want of more ware; and lastly, it should have the odor of indigo instead of the odor of the pastel.

In America, pastel is known by the name of ball or German woad. (See article, Pastel.)

POTASH-VAT, SOMETIMES CALLED ASH-VAT.

This vat is usually of the same size as the woad-vat, but we have seen them nearly one-third larger. The vat is filled with water, and heated to 180° or 190°. The materials used are, fifteen lbs. of madder, thirty quarts of bran, twenty-five lbs. potash or pearlash, and twenty lbs. of indigo. In the first place throw in the bran and madder, rake it up, and in three or four hours add the indigo and potash; rake it up *well*, until all the

materials are well mixed. Let this be all completed by the middle of the afternoon. By eight o'clock the next morning it should show signs of having sprung its indigo. Now rake it up again; then rake it again about four o'clock in the afternoon, and cover it up for the night. Do not allow the heat to fall below 130° Fahr.

On the following morning dip in a lock of wool, for fifteen or twenty minutes, and if it comes out a thin-looking green color, and in the course of three or four minutes it turns to a grayish-looking blue, and the liquid has a dark bluish-green color, it is in need of greater fermenting force. In this case take out of the vat half a barrel of the liquor, and put into it six quarts of bran, three lbs. of hops, and three quarts of molasses, and boil it for half an hour, being careful that it does not boil over. After boiling, add three lbs. of madder, and when it has settled turn the clear liquor into the vat, and then rake up well; in the afternoon rake again. Next day it should be ready to color in.

Should the lock of wool which you have tried in the vat come out a fair-looking green, and turn to a blue in four or five minutes, and yet not be so good a blue as you would desire, it is evident that the materials are correctly proportioned, and that it only requires a little more time to produce the correct effect; and all that it requires is a good raking up, which do, and then rake again in the afternoon; and the next morning you may commence coloring in it.

We can obtain the deep blues in this vat with greater celerity than in any of the others, which fact, no doubt, depends upon the great power potash has of dissolving indigo, over that possessed by lime. Experience has demonstrated that the ash-vat has the advantage as regards celerity of nearly one-third, but this advantage is balanced by the inconvenience it places us under when we want to get light shades.

We can color a larger quantity of wool at a time in an ash-vat, than we can in the woad-vat, as the ash-vat has no sediment to speak of, or none in comparison to a woad-vat, and

the trammel and net can be suspended lower in the vat without touching the sediment. The manipulations are the same in working an ash-vat as for a woad-vat. Care should be taken in regard to coloring too much in one day, as it will tire the vat. Should you overwork it by this extra coloring, you will lose more time in getting the vat in good condition again than you have gained in doing so much in it, besides the extra expense of materials to restore it to its former condition. After doing a day's work in the vat, it should be examined three or four hours after it is raked in the afternoon, in order that you may know whether it requires more potash, or bran and madder. If it is too *open*, and the indigo does not seem to be in solution, you must serve it with *ware;* but should the liquor have a deep blue-green color, give madder and bran, or a ferment made as above described. In either case, your judgment and experience must dictate the kind as well as quantity of materials that the vat requires.

After working the vat a couple of days, you must give it more indigo, in order to keep it up to its proper strength; give as much indigo as, in your judgment, the wool that has been colored has taken out of the vat; and, at the same time, give as much potash (in weight) as you do of indigo, and half as much madder and bran. You can proceed so from day to day, making these additions, *always* after you have finished coloring for the day, or you may serve every other day. Some dyers prefer to renew the vat every day, while others every three or four days; but in either case, keep the vat up to its regular standard, and in good working order, until such time as you think it should be worked out and reset; then you will proceed as above, only leaving off serving with indigo.

We can easily discern the inferiority of the wool colored in an ash-vat, from that colored in either the woad or pastel vat, in beauty, durability, or solidity of color. It is more expensive (for the reason given in regard to the German or soda vat), and does not possess any of those kindly qualities

which are communicated to the wool when colored in the above-named vats. A great paucity of color is also perceptible; and the wool, when you look down upon it, is darker than wool colored in a woad-vat; but if held up, and viewed by a transmitted light, it looks gray and devoid of intensity, and has no vivacity of shade.

The reason of this is, that the particles of indigo being coarser, and being farther apart than they are with a *woaded* vat, and lying more loosely upon the fibre of the wool, there is no under-color such as the woad will give to wool.

These objections to an ash-colored wool are thus accounted for: In the ash-vat the solvent of the indigo is a fixed alkali (it being potash), while the solvent in the woad-vat is a volatile alkali (ammonia); the potash forms a coarser or thicker solution, causing the particles of indigo not to be so finely attenuated, the solution of potash being so coarse that it prevents the particles of indigo from penetrating into the fibre of the wool, and lays them on the outside of the wool in a loose and scattered condition. In the case of *woad*-colored wool it is entirely different, for as the ammonia (in the woad-vat), being the solvent of the indigo, is finer and a stronger alkali, it naturally divides the coloring molecules in a more minute and multifarious manner; and it also being of a subtle nature, it will penetrate the fibre of the wool much better, and these finely divided particles combine more intimately with the wool; the indigo being divided into a greater number of surfaces is more deeply combined with the wool, which accounts for its superior brilliancy and permanency, as the greater the quantity of reflected surfaces there is to view, and the more minute is the division in any color, the higher will be the intensity of the shade.

Wool colored in an ash-vat always works harsh in carding and spinning, no matter in how good a condition the vat may be, whether you use for the alkali potash or carbonate of soda, although the soda is a milder and softer alkali (it containing more carbonic acid is why it is milder); but for all that, wool

colored in an ash-vat will always be harsh and tender, and the goods, after being finished, will never look so well, or feel so soft, as when the wool is colored in a woad-vat.

The ash-vat is now seldom used, except in small mills, for coloring wool; but it is used to a large extent for coloring cotton-yarns, for bedtickings and denims.

GERMAN OR SODA VAT.

This vat is of the same dimensions as the woad-vat. It is filled with water and heated up to 200° Fahr.; there is then thrown into it twenty-five pounds of carbonate of soda, fifteen pounds of indigo, seven pounds of ware, and one and a half to two bushels of wheat-bran; it is then raked up well, and left for two or three hours; it has to be watched carefully during the progress of fermentation, regulating it by giving it either ware or soda; and, if correctly managed, it will be ready to color in after fifteen or eighteen hours from the time it was set.

The smell is the only criterion to be governed by (which is a strong ammoniacal odor), as sometimes the solution will be of a grass-green color, at other times a deep olive color, and still the vat will be in good working order; so it would not always do judge by the looks of the liquid in regard to the condition of the vat. This vat requires greater care, and is more difficult to manage, than the potash-vat; it differs from the potash-vat, as the potash is replaced by the crystallized carbonate of soda and caustic lime, the lime giving to the carbonate of soda a caustic nature.

The German, or soda vat, will do more work, in a given time, than any other vat that I ever worked; but it is not so economical as other vats, so far as the amount of indigo used is concerned, as you have to color the wool so much darker than the pattern you have to match, as the indigo lies more

loosely upon the wool, and does not penetrate into the fabric of the wool like the woad or pastel vat, losing more indigo in the operation of fulling and scouring than the wool does that has been colored in either of the above-named blue-vats. The manipulations in working a soda-vat are the same as in working the other vats. When indigo is added, bran, lime, and soda are added also, so as to constantly maintain the fermentation at a suitable point. (See Fermentation of the Woad-vat.)

BRAN AND MADDER VAT.

This vat we have used to a great extent, and, for a dyer who has but little experience in working a blue-vat, it is the best one for him to set and use, it being both simple and easy to work, which any dyer will be convinced of after perusing the method of setting and working it from day to day.

The dimensions of the vat are as follows: six and a half feet deep and five and a half feet diameter; this is filled with water and heated to 170° Fahr. In the forenoon you commence to set it by throwing in six bushels of bran, twenty-five pounds of madder, two pails of molasses (the poorer the molasses the better); rake these materials up for half an hour, then cover up the vat. In the afternoon, at three o'clock, rake up again.

The next morning, at eight o'clock, add two quarts of *ware* and two pails of indigo (previously ground in the mill with water), — which is about twenty pounds in the dry state; rake up well. At 3 P. M., add two quarts of *ware* and one pail of molasses; rake up well.

The next morning add three quarts of *ware*; rake up. At 4 P. M., add six quarts of *ware* and rake up.

Keep the heat up all the time to 135°.

The next morning (or fourth day), at eight o'clock, add six quarts of *ware* and a half pail of indigo; rake up; then

rake up again at eleven o'clock, then at two o'clock, then at four o'clock; at each raking add two quarts of *ware*. The next morning it should be ready to color in; the liquor will be of a yellowish-green color, the flurree will be copper-colored and will lie well to the backside of the vat; on dipping the dish into the liquid, with the edge downwards, and taking it out, the liquid will hang, like thin syrup, from the edge of the dish, as it does from a woad-vat, and will have the same ammoniacal odor; its characteristics are the same as a woad-vat, with the exception of the color of the liquid, which is more yellow.

After the first day's coloring, and you are raking up for the last time, add two pails of indigo, one quart of molasses, and one pail of ferment, and rake up well.

To Make the Ferment.

In a barrel of water put six quarts of madder and six quarts of bran, boil these for one hour (but care must be taken that it does not boil over), let it settle, and use the clear solution; or you can stir it up and use it that way; this is optional with your own views.

After the first day's coloring, when working the vat, give, one day, three pails of the ferment; the next day, one quart of molasses, and so on each alternate day.

Give indigo according to the amount taken up by the wool, in which your judgment must dictate (for full blues, about five pounds for every hundred pounds of clean wool).

Give five quarts of lime (*ware*) for every hundred pounds of clean wool, or five pounds each day; the vat must be worked very *open*, or, as dyers say, *soft*. There is very little danger of losing such a vat, as the fermenting powers of the bran and madder are weak and are soon exhausted. A large amount of wool can be dyed in a day in this vat, as it is ready to dip again in one hour after raking; yet it is not economy to dip over three times a day in it. Fifty pounds of

clean wool is sufficient to dip at one time. The manipulations are the same as in a woad-vat.

SAL-SODA BLUE-VAT.

Dimensions: seven feet deep, six feet diameter.

Heat the vat to 130° Fahr., then add two and a half pounds of indigo, thirty-three pounds of sal-soda, and thirty-six pounds of bran; rake these materials up well, cover up the vat and let it remain twelve hours; then add two and a half pounds of slacked lime (ware); rake up again; if the heat is not up to 130°, heat it up to that temperature, and leave it covered up for twenty-four hours. By this time the solution should be of a yellowish-green color, the flurree of a blue, coppery shade, and the liquid should have a sharp, pleasant odor. Now immerse a lock of wool in the liquid for ten or fifteen minutes; it should come out a clear, deep green, and change to a blue very quickly by the air. After the green has passed off, dip the lock into the liquid again for the same length of time, and when taken out, if it has not gained in depth of color, add *ware* to the vat, or it will become putrid; which you will soon observe, as the flurree will become colorless, the liquid will have a fetid smell, and the deposit of the vat will contain no particles of indigo; but in giving the ware be careful and not give too great a quantity, as by so doing you will stop the fermentation too soon. If you should overcharge the vat with ware, you must add bran to start the fermentation again; and after giving bran in this instance, do not give any ware under twenty-four or thirty hours after giving the bran. In adding the ware in sufficient quantities the vat grows better and the liquid more yellow, the flurree more blue and persistent; the amount of ware necessary to bring the vat to a state of perfection should be from sixteen to twenty pounds. When adding indigo, after the setting of the

vat, you should add one pound of molasses, one pound of sal-soda, and seven pounds of ware, to every two and a half pounds of indigo added.

If the vat is used every day, the above materials should be added each day after coloring, in the afternoon, and on the following morning, if the vat is in a good state; if the liquid is yellow and the bran does not rise to the surface, if there is no sign of fermentation, do not give any ware for twelve hours. This kind of a vat is used for four or five months, and when it is to be re-set they take up the sediment from the bottom and preserve the liquid for a new vat, and it needs but one-half the materials to start another vat.

The temperature for working is from 110° to 119°, but the higher the temperature the darker and more violet will be the color. This vat is from a French dyer named Grison, who was a pupil of Chevreul, and has been a practical dyer for forty years; he is also a good chemist.

TIN=(Sn).

Tin, in its color and lustre, is the nearest to silver of any of the metals, only differing in lustre by having a somewhat bluer hue. It exhibits a high metallic lustre, similar to silver. Tin is one of the few metals known to man in the antediluvian period of his existence, and was extensively used in all countries having any pretensions to civilization.

Tin does not occur naturally in a metallic state. It is found as oxide in tinstone or tin ore (SnO_2), containing 79 per cent. of metal, and as sulphuret of tin in combination with other metallic sulphurets in tin pyrites. Tin ore is found either interspersed in veins, or in secondary formations deposited by water, and in the alluvial deposits formed by the washing away of fragments of the primary rocks. These ores are not, as a rule, simply composed of pure oxide of tin, but contain

various other metallic compounds, — such as sulphur, arsenic, zinc, iron, and copper. In some instances, tin ore is found in Cornwall, Malacca, and Banca, in the beds of the rivers, and the tin thus found is very pure, because the mechanical separation of the ore from its impurities has been performed by nature itself, and, as a consequence, these ores yield a purer metal than the ore obtained from veins, which has to undergo the process of dressing, washing, and roasting previously to being smelted, to get rid of the arsenic, sulphur, and antimony.

The tin ore found in Cornwall County, England, has, for over two thousand years, yielded tin. This tin has to be smelted in accordance with an ancient stannary law. The stronger and purer the tin is, the more it crackles, or creaks, when it is bent. When rubbed with the hands, it imparts to them a very peculiar odor. A cubic foot of tin weighs — according to its purity — from three hundred and seventy-five to four hundred pounds. The specific gravity of pure tin is 1.280, and, by hammering, can be increased to 1.290. It fuses at 228°, and boils at 442° Fahr. It is then at a white heat, and if kept at this heat in contact with the air, it will become covered with a grayish coating, which is a finely divided metal, called tin-ash, and protoxide of tin. This substance will be converted into stannic oxide — known as putty-powder — if the heating of the tin is continued for a short time after this substance has formed upon it.

We might give a description of the different combinations and applications of tin, but we will omit them, as they are not applicable to our particular branch of science, or to the art of dyeing.

Tin is known by the names of common tin, block tin, and grain tin. The latter is the only kind fit for the purpose of making tin-solutions. It is brought from England in large ingots; then melted and moulded into small, slender bars, and in this form it is received by the dyer.

Tin-Solutions, or Stannous Chlorides $=(SnCl_2)$.

Observations on Making Tin-Solutions.

In preparing these solutions, you must, in the first place, have the tin well granulated, or feathered, and it should be of the best kind (see article, Tin). The tin must be added to the acid at intervals, and a small quantity at a time, so that it may be dissolved with as little disengagement of the acid-gas as possible, and the solution should be kept at as low a temperature as is compatible with the combination of the acids and tin. These observations apply with the greatest force in making nitro-muriate of tin.

In dissolving tin in muriatic acid, you will sometimes notice that when the tin is in solution, some parts of the tin are dissolved, while some of it seems to be covered with a crystalline substance which you have a great deal of difficulty to dissolve, and it occasions both loss and annoyance. This can be avoided by stirring the solutions at intervals. This coating of the tin is caused by one part of the solution becoming denser than some other portions,—an action of a galvanic nature being induced between those parts of the tin in the stronger portion and the parts in the weaker portion of the solution, causing a deposit of oxide of tin upon the metal in the weaker portion of the solution.

The preparation of these solutions is a matter of much pride among dyers, and every dyer will have some little peculiarity in making them that he keeps to himself, *as a great secret*, and on the strength of which he thinks his success depends. These little *peculiarities* are nothing more than the proportioning of the acid and the tin, and the way of mixing them.

The first process of preparing the solutions of tin is to *feather* the tin, which is done by melting the bar in an iron ladle, or some other convenient utensil. After it is melted, pour it into a vessel filled with cold water, holding the melted tin as high as possible, so that it may pour in drops into the water. In this state, a very extended surface of the metal is

exposed to the action of the acid. In giving the tin, I do not always go by the weight, but give enough to saturate all the acid. Crystals of tin — or tin-salts as they are termed in the trade, and understood to be chloride of tin — are muriate of tin crystallized by evaporation, and their formula is $SnCl_2+2H_2O$, while the formula for chloride of tin is $SnCl_2$. To prepare crystals of tin correctly, muriatic acid-gas should be caused to act on granulated tin placed in earthenware receivers, and the concentrated tin-salt solution thus obtained evaporated in block-tin vessels.

These crystals are colorless and transparent, and very deliquescent, and of course very soluble in water. When they are dissolved in water, and left to stand awhile, there will be a deposit of basic salt, but by adding some muriatic or tartaric acid to the solution, the basic salt will dissolve again.

The introduction of tin as a mordant for the scarlet shades, is considered as forming an era in the art of dyeing. Berthollett, in his "Elements of Dyeing," speaks of it as follows: "A short time after cochineal became known in England, the scarlet process, by means of tin solution, was discovered. About the year 1630, Cornelius Drebbel observed, by an accidental mixture, the brilliancy which the solution of tin gave to a solution of cochineal. He communicated this discovery to his son-in-law, Kuffeler, a dyer in Leyden. He improved upon the process, kept it a secret from his fellow-workmen, and brought into vogue the color which bore his name." "A few years afterwards a German chemist found out the process, and brought his secret to London about the year 1643." "It was soon known and diffused over Europe, and afterwards whenever a new dye-drug was introduced, the solution of tin was always applied to it, and it became a standard mordant for the red dyewoods, and even for logwood, on cottons."

I cannot impress too strongly upon the mind of the dyer, the necessity of the care and judgment requisite in preparing his tin solutions; not to add the tin to the acid in large quantities, but to add it a little at a time, and when that is dis-

solved, to add a little more, and so on until he has given all the tin to the acid, and let the solutions be at least twenty-four hours old before using (unless otherwise recommended in recipe for making the different solutions). As a general thing, dyers are in too great haste in making their tin solutions, and will throw in one handful of tin after the other, before the first is dissolved. When the tin is added in this manner, the action of the acids upon the tin will become violent, and too much heat is generated, causing a great loss in the strength of the solution. This is more particularly the case in making nitro-muriate of tin, for if too much heat is generated, it decomposes the nitric acid, ammonia is then formed in the solution, and when it becomes cold, a large quantity of peroxidized tin precipitates in a sticky, silver-colored and gelatinous mass, at the bottom of the vessel, and such a solution will never give a good clear hue to the color. The slower the tin is dissolved, the more permanent the solution, and brighter the colors.

"Tin combines with oxygen in three different proportions."

"Protoxide (SnO),
"Sesquioxide ($Sn_2O_3=SnO,SnO_2$),
"Peroxide (SnO_2)."

MURIATE OF TIN=($SnCl+2HO$.)

To make this solution, take two parts by weight of muriatic acid, and one part of tin (see directions for making tin solutions, page 370). Some dyers give as much tin as the acid will eat, let it be more or less. After the tin is all dissolved, and has a few days' age, it will have an agreeable and fragrant smell, and a sparkling, glistening appearance. This is caused by a portion of the solution having crystallized, and the crystals are floating in the solution. If this solution is evaporated by gentle heat, the water in the solution is driven off, and by cooling, the whole would crystallize. It is then called

Crystals of Tin $=(SnCl_2+2H_2O)$.

These crystals contain three proportions of water, or about twenty per cent., but according to the investigations made by Dr. Penny, they contain only two proportions, or fourteen per cent. of water. The composition of muriate of tin is—

Tin (Sn), ...	52.04
Chlorine (Cl), ...	31.81
Water (HO), ...	16.15=100
Prime equivalent, ...	14.46
Specific gravity, ...	22.93

Murio–Sulphate of Tin.

Take two parts by weight of muriatic acid, one part of sulphuric acid, add to this last acid as much water as the weight of the acid, and when it has cooled from the heat caused by the mixture of the water and acid, then mix this with the muriatic acid, and add one part of tin.

This solution is sometimes called lac spirits, and yellow spirits. Some dyers use sal-ammoniac in place of the muriatic acid in preparing this solution. This solution is seldom, if ever, used on cotton yarn or cloth. For yellows on wool, I do not think so good and bright colors can be produced by using the sal-ammoniac, as those yellows that have for their mordant spirits made of sulphuric and muriatic acids. For crimsons, I think the spirits made with sal-ammoniac and sulphuric acid are preferable to the muriate or murio-sulphate of tin. This solution crystallizes like the muriate of tin.

Murio-Sulphate of Tin for Lac-Dye.

Take 5 parts of hydrochloric acid (muriatic acid, H Cl), 1 part of sulphuric acid, and 1 part of tin (all by weight), and proceed as with the preceding solution.

Nitro-Muriate of Tin.

A mixture of nitric acid and muriatic acid will dissolve about one-half its whole weight of tin. To make this solution, take 4 parts of nitric acid and 3 parts of muriatic acid; mix these together, then add $1\frac{1}{2}$ ounces of tin to the pound of acids used.

This solution ought to show a fine amber-yellow color to be in the greatest perfection for coloring scarlet shades; but for yellows, or for crimson shades, it may be of a browner yellow color, and be more highly charged with tin.

Some dyers make this solution thus: 1 lb. of nitric acid, 3 lbs. muriatic acid, and add tin until it ceases to dissolve it.

This solution does well for a deep, heavy red, when hypernic or camwood is used for the coloring-matter, but it is not suitable for reds when cochineal or lac is used. If you want a more crimson hue to the red, make the solution of 1 lb. nitric acid and 5 lbs. of muriatic acid; mix these acids together, then add $2\frac{1}{2}$ ounces of tin to the pound of mixed acids.

Instead of using muriatic acid for preparing this solution, some dyers make it thus: 6 lbs. nitric acid, 1 lb. of water, 1 lb. sal-ammoniac; then add 10 ounces of tin. Note that the sal-ammoniac is dissolved in the water before it is added to the acid.

These solutions of nitro-muriate of tin cannot be crystallized. The different solutions of tin are now seldom prepared by the dyer, but are purchased already prepared. I would advise every dyer to prepare his own tin solutions, as he will then be certain as to the amount of tin he has in the solution; while, in the other case, he is not certain as to the amount of tin there is to the acid of the solution he is using.

Scarlet Spirits.

This is the best tin solution I ever used for scarlets, and is made thus: 4 quarts of nitric acid, 1 quart of water, and 1

quart of muriatic acid; mix these three articles together, then add $1\frac{1}{2}$ ounces of tin.

In dyeing use as much of this solution as you do of muriate of tin; that is, supposing you wish to use 4 lbs. of muriate of tin for the mordant, then use 2 lbs. of muriate of tin and 2 lbs. of these spirits.

Another Scarlet Spirit Solution.

Break up 2 lbs. sal-ammoniac, mix it up well with 16 lbs. feathered tin, then put it in a carboy, add 80 lbs. of muriatic acid, and when the agitation caused by the mixture has ceased, place a distilling tunnel in the carboy, stopping the neck of the carboy around the tunnel tight; then add, through the tunnel, 20 lbs. sulphuric acid.

Nitrate of Tin.

Take 2 lbs. of water, add to it 1 lb. nitric acid, use of tin 3 ounces to the pound of acid. In making larger quantities use the same proportions.

This solution is not used now as much as formerly. A concentrated solution of this salt is not decomposed by being boiled, but when it is diluted with water, the oxide of tin is precipitated. This tin solution is largely used in France for dyeing iodine-green.

COTTON MORDANTS.

Nitrate of Iron.

Twenty lbs. nitric acid, 36°, $2\frac{3}{4}$ lbs. clean iron turnings; add the iron gradually.

Some dyers use nitric acid, and give it all the copperas (SO_4Fe) it will dissolve, without any regard to the amount. Nitrate of iron should be kept in a dark place. Nitric acid containing much sulphuric or muriatic acid, does not

answer for this solution, as the salts of these acids are crystallizable. Therefore, if these acids are present in nitric acid they will cause a crystalline mass to form at the bottom of the vessel in which the iron is dissolved. All the commercial nitric acid contains a small amount of these acids, but the amount is so small that it is of no material importance.

Acetate of Alumina.

To 3 gallons of boiling water, add $4\frac{1}{2}$ lbs. alum, $5\frac{3}{4}$ lbs. white sugar of lead. Boil this until the alum and lead are dissolved; let it stand twelve hours; use the clear solution. This solution should indicate 8° Baume, and weigh about fifteen pounds.

Neutral Acetate of Alumina.

Thirteen lbs. water, $\frac{1}{2}$ lb. sal-soda. $4\frac{1}{2}$ lbs. alum, $3\frac{1}{2}$ lbs. white sugar of lead. Boil until all is dissolved; use the clear solution.

Neutral Acetate of Alumina.

In $3\frac{1}{2}$ gallons of boiling water, dissolve $4\frac{1}{2}$ lbs. alum, $\frac{1}{2}$ lb. soda crystals, $3\frac{1}{2}$ lbs. white sugar of lead. This should make $16\frac{3}{4}$ lbs. clear mordant, and will stand at 10° Baume.

Acetate of Lead.

Four lbs. brown sugar of lead, 2 lbs. litharge, 3 gallons of water. Boil until all is dissolved. This gives 18 lbs., at 45° Baume, and is the best for oranges.

Another Acetate of Lead.

Six quarts of water, $5\frac{1}{2}$ lbs. brown sugar of lead, $2\frac{3}{4}$ lbs. litharge, are boiled together until all is completely dissolved, and the solution will indicate 55° Baume.

Acetate of Copper.

Dissolve in 3 quarts of water $3\frac{1}{4}$ lbs. blue vitriol. Dissolve in 1 quart of water $2\frac{1}{4}$ lbs. white sugar of lead. After

these are completely dissolved, turn them or mix them together, and use the clear solution only.

Another.

One gallon of water, 4 lbs. blue vitriol (dissolve). One gallon of water, 3 lbs. white sugar of lead (dissolve). Mix them as above, and use clear solution.

Red Spirits.

These spirits are for coloring reds with camwood, Brazil-wood, and other red woods, and are sometimes called *nitro-muriate* of tin, but more commonly called red spirits. Mix together 2 lbs. nitric acid, and 6 lbs. muriatic acid. Then add feathered tin in small quantities at a time (see Directions for Tin Solutions), until the acid will dissolve no more. Then pour off the clear solution, and keep it in a dark, cool place. This spirit is for a deep and heavy red; but in coloring reds, if a red is not wanted to be so deep or decided a red, but of a bluer or crimson hue, it requires a solution made thus:

Two lbs. nitric acid, 10 lbs. muriatic acid, giving tin as above described.

Barwood Spirits,

so called on account of their being used as the mordant for barwood. They are prepared thus:

Two lbs. nitric acid, 12 lbs. muriatic acid, and 1½ ounces of tin to the pound of the mixed acids; or thus:

Two lbs. nitric acid, 8 lbs. muriatic acid, and 2 ounces of tin to the pound of mixed acids. There are other slight variations in making this tin solution. They consist in varying the muriatic acid from 4 to 7, but an excess of tin must be avoided. I will here state, that the working strength of the spirit-tub for cotton-yarn is from 2° to 3° Twaddle. Coloring barwood-reds requires a great deal of experience and attention, in order to produce good colors.

Plum Spirits.

This solution derives its name from being used with logwood. Its color is a deep plum. By some dyers it is termed a *French tub*. It is prepared as follows: 2 lbs. nitric acid, 14 lbs. muriatic acid. Mix these acids. Then add by degrees 2 ounces of tin to the pound of mixed acids; or 2 lbs. nitric acid, 10 lbs. muriatic acid, and $1\frac{1}{2}$ ounces of tin to the pound of acid. For each 2 lbs. of logwood used, add 1 lb. of the above spirits.

Spirits for Aniline Colors on Cotton-Yarn.

One lb. muriatic acid, $\frac{1}{2}$ lb. nitric acid, 1 pint sulphuric acid. Mix these acids. Then add 2 lbs. of feathered tin, a little at a time. When the tin is all dissolved, the solution is ready for use. To use the spirits, steep the yarn for three or four hours in a cold sumac solution. Wring out the yarn. Then give the yarn seven turns in the spirit-tub, using one pint of spirit for ten pounds of yarn (this must be a cold bath). Wash off the yarn from the spirits, and wring it out. Then, in a clear bath of water, add any of the aniline dyes, and color at 190° F. Wash off the yarn before it is hung up to dry.

AMMONIA=(NH_3).

Ammonia occurs in the atmosphere. Ammoniacal salts are met with in a few minerals, and in volcanic districts. But the greater amount of ammonia and ammoniacal salts used industrially, is obtained from the dry distillation of coals, bones, and animal substances; also by the distillation of stale urine (lant), and from water-gas, or, more properly speaking, water through which coal-gas has passed. Ammonia is composed of one part nitrogen, and three parts hydrogen (formula, NH_3), condensed to two volumes of ammonia gas,

is colorless, and has a peculiar and well-known odor, with a sharp, biting taste.

Water at 59° F., will absorb 727 times its bulk of this gas. Water at 40° F., will absorb 1,050 times its bulk of this gas. The solution is then called liquid, or aqua ammonia, and, by some chemists, called or termed spirits of sal-ammoniac. The specific gravity is 0.824 (=31.3 per cent. of NH_3).

The following table shows the specific gravity of liquid ammonia, and the percentage of ammonia that it contains:—

Specific Gravity.	NH_3 Per Cent.	Specific Gravity.	NH_3 Per Cent.
0.875	32.50	0.959	10.0
0.824	31.30	0.961	9.5
0.900	26.00	0.963	9.0
0.905	25.39	0.965	8.5
0.925	19.54	0.968	8.0
0.932	17.52	0.970	7.5
0.947	13.46	0.972	7.0
0.951	12.00	0.974	6.5
0.953	11.50	0.976	6.0
0.955	11.00	0.978	5.5
0.957	10.50		

The specific gravity of aqua ammonia ranges from 0.875 to 0.995, and the per cent. of ammonia contained ranges from $32\frac{1}{2}$ to $1\frac{1}{2}$ per cent.

There are various methods employed to prepare aqua ammonia, one of which is to mix equal weights of lime and muriate of ammonia (sal-ammoniac, NH_4Cl), well powdered, and then expose them to a gentle heat in a retort; then the lime combines with the muriatic acid (HCl) contained in the sal-ammoniac and liberates the ammoniacal gas, which is received into a jar over mercury for experiments; but for mechanical and manufacturing purposes, it is conveyed by a tube into water. In this state it is known as aqueous ammonia, or spirits of hartshorn.

Another method of preparing or manufacturing aqua ammo-

nia, is by decomposing caustic lime (CaH_2O_2) either with chloride of ammonium (sal-ammoniac, NH_4Cl) or sulphate of ammonia (NH_4, $S2O_4$); ammoniacal gas is set free, and then is absorbed by water, care being taken that the lime is in excess.

We might give a detailed account of the preparation of liquid ammonia, but we defer doing so, as it would take up space, and would not be of any material advantage or benefit to the practical dyer. Therefore we will only speak of its different forms and combinations in which it will be of use to us as dyers.

Sal-ammoniac (NH_4Cl). This substance is sometimes found as a natural formation; it is met with on Mounts Vesuvius and Etna. It was found at one time in such large quantities on Mount Etna, that it became temporarily an article of commerce at Catania and Messina. This substance is manufactured from gas-water, or by the distillation of animal matters, and then saturating them with muriatic acid (HCl) which will crystallize in a very impure state. These are then collected, and placed in iron pots; these pots are set into furnaces that are lined with fire-brick, and have large covers, made of lead, fitted to them. Fire is then applied, the sal-ammoniac sublimes and will collect as a crust upon these leaden covers, from which it is removed from time to time as it collects.

From the thirteenth to the middle of the eighteenth century, this salt was imported into Egypt, where it was prepared by the combustion of camel's-dung. The camel feeds almost exclusively upon plants containing salts, and it is said that sal-ammoniac is often found ready formed in their stomachs. The sal-ammoniac after having sublimed with the soot caused by the burning of the dung, is collected and refined by a second sublimation.

In localities where this dung is used as fuel, it has been tried to obtain sal-ammoniac by burning it with common salt. The first sal-ammoniac manufactory in Germany was estab-

lished by Gravenhorst Brothers at Brunswick, in 1759. This salt, from whatever source is is obtained, has to be purified by sublimation in cast-iron cauldrons lined with fire-clay. The crude sal-ammoniac is put into these cauldrons and then tightly rammed; heat is applied, gently at first, so as to drive off the moisture; after this is accomplished the heat is increased, but the temperature has to be regulated, during this heating process, to a nicety, for if too low a heat is maintained, it will yield a very loose salt, and if the heat is too high, the organic matter contained in the sal-ammoniac is liable to give off matter that would spoil the appearance of the sublimated salt, and would interfere with its good quality. Experience has proved that it is very necessary to have very large sublimation vessels. When the sal-ammoniac cake has become of sufficient thickness (four or five inches), the heat is withdrawn and the cake removed; it is then dried in an oven and afterwards packed for the market.

At the present day sal-ammoniac is often sublimed in earthenware vessels, or in large glass flasks, the crude salt being first mixed with twenty-five to thirty per cent. of its weight of powdered animal charcoal, then dried over a good fire.

The sal-ammoniac of commerce, we find either in a crystalline state, or as a compact, fibrous, sublimed material, exhibiting the appearance of having been formed in layers. Crystalline sal-ammoniac is made by adding to the re-crystallized sal-ammoniac a strong boiling-hot solution of the same salt, so as to produce a thickish magma, which is next placed in moulds similar in shape to those used for making loaf-sugar, then, after draining, the loaf of sal-ammoniac is taken out of the moulds, dried, packed in paper, and is now ready for sale. This is the kind of sal-ammoniac that is used in chemical laboratories by pharmaceutists and by veterinary surgeons; it is used in calico-printing and for the preparation of platinum, snuff, and for making mastic or iron cement. The cement is made as follows: one part sal-ammoniac, two

parts of sulphur and fifty parts of iron-filings; this is used for cementing iron pipes for water, steam or gas.

Sal-ammoniac (NH_4Cl) consists, in 100 parts:—Of ammonia, 31.83; muriatic acid, 68.22; or, ammonium (NH_4), 33.75; chlorine (Cl), $66.25 = 100$. Sal-ammoniac is used in the woolen dye-house for scouring wool, and with logwood in coloring some particular shade of purples, violets, and dahlias.

Sulphate of ammonia (NH_4SO_4). This substance is met with in small quantities in the mineral known as mascagnin, but in larger quantities in the boracic acid (B_2O_3) of Tuscany. This salt is prepared from the ammoniacal water of gas-works, from urine (lant), and by the dry distillation of bones, by the aid of sulphuric acid, or else by double decomposition by means of gypsum ($CaSO_4$), or by sulphate of iron (SO_4Fe). This solution is evaporated to crystallization; if it is obtained from gas-water that contains some of the tarry matters, the crystals are usually of a deep brown color, and consequently have to be purified by being dissolved in hot water, then filtered through animal charcoal, and then re-crystallized by rapidly evaporating the solution and removing the crystals as fast as they form, by the use of perforated ladles. The crystals are then drained by being placed in baskets constructed for the purpose; after draining a few hours, they are then quickly dried on hot fire-clay slabs, by which operation any particles of tar left in the crystals are decomposed.

Sulphite of ammonia, obtained by saturating carbonate of ammonia solution with sulphurous acid gas, is, when exposed to the atmosphere, gradually converted into sulphate of ammonia. The sulphate of ammonia, industrially speaking, is far the most important of all the ammonia salts, because of its being very largely used in preparing artificial-manure mixtures, and by itself, for the same purpose; it is extensively employed in alum-making, and it is the starting-point of the preparation of chloride of ammonia (NH_4Cl), carbonate of ammonia, aqua ammonia, and other similar products. Sulphate

of ammonia is used as a mordant along with alum and salt for deep logwood blues. The proportions are as follows: two of sulphate; nine of salt; eight of alum.

ARGOL, OR CRUDE TARTAR.

"Crude or red tartar is deposited upon the sides of casks containing wines, carrying into its crystallization some of the coloring matter of the peculiar kind of wine from which it was deposited; this is the cause of the difference in the color of the argol. This crude tartar is employed by dyers in all common and dark colors, where a supertartrate of potash is required as an auxiliary to the mordant, it being cheaper than the white, or cream of tartar so called, the cream of tartar being obtained from argol, by precipitating or retaining its coloring matter with charcoal, bone-black, clay, &c."

In dyeing any and all colors where tartar is required as a part of the mordant, I prefer the red to the white or cream of tartar, as it contains more tartaric acid than the cream of tartar, unless the red tartar is too much adulterated with red sandstone, which is quite often the case. This adulteration, however, can be very easily detected by dissolving some of the suspected tartar in boiling water; the tartar will all dissolve, and the sandstone will deposit at the bottom of the utensil in which you have dissolved the tartar.

SUPER-TARTRATE OR BITARTRATE OF POTASSA (Potash), COMMONLY CALLED CREAM OF TARTAR, ($KO,2C_4H_2O_5$).

This salt is of general application in woolen dyeing, as an auxiliary to the mordants, but is more especially used along with the tin solutions and with alum.

Tartar of itself is a feeble mordant, but when used with chloride of tin or alum, it is then a strong mordant, which is due to the decomposition; the sulphuric acid of the alum, and

the chlorine with the tin, take from the tartar the potash it contains, and the alumina is converted into a tartrate; the tin is also converted into a tartrate of tin. It is very probable that the coloring matter of the tartar removes the alumina or the oxide of tin more readily from tartaric than from sulphuric acid, as it converts the sulphuric acid of the alum into tartaric acid; otherwise the alum is converted into a tartrate of alumina. In this state there will be no free sulphuric acid, which would certainly be of injury to the wool as well as to the coloring matter, while free tartaric acid will have no bad effect upon either, especially the wool, as the wool dissolves, and an equivalent of the mordant takes its place, as spoken of in regard to alum.

"Cream of tartar, or supertartrate of potash is but slightly soluble in water, as it takes sixty times its weight of cold water, and fifteen times its weight of boiling water to dissolve it; but one-fifth of its weight of borate of soda (borax) causes it to be very soluble."

It is composed, in 100 parts:

Tartaric acid, ...	70.45
Potash, ...	24.08
Water, ...	4.75=99.28

We have said that the crude tartar was a deposit from wine during fermentation. The tartar that is deposited from red wines has a red color, and is called *red tartar*, while that derived from white wine is a dirty-white color, and called *white argol*. Both kinds consist of potash united with an excess of tartaric acid ($C_8H_2O_{10}$), forming bitartrate of potassa (potash, $KO,2SO_3+2HO$) rendered impure by tartrate of lime ($CaO,C_4H_2O_5$), with more or less coloring matters, and other matters which are deposited during the clarifaction of the wine. The deposition of the tartar is thus explained: "The bitartrate exists naturally in the juice of the grape, held in solution by saccharine matter. When the juice is

submitted to fermentation in the process of converting it into wine, the sugar disappears, and is replaced by alcohol, which, not being competent to dissolve the tartaric acid, allows it to precipitate as a crystalline crust." It is from this substance that the bitartrate of potassa (cream of tartar) is obtained, by a process of purification.

The process of purifying the crude tartar is founded upon the greater solubility of bitartrate of potassa in hot water than in cold. The crude tartar is first ground fine, and then boiled with water in copper boilers. The solution is transferred to earthen pans. After cooling, there is a crystalline layer deposited, which is free from the natural color of the crude tartar. This is re-dissolved in boiling water, and the solution is then mixed with four or five per cent. of pipe-clay; it is then evaporated to a pellicle. The pipe-clay precipitates along with the coloring matter, and the clear solution, as it cools, deposits white crystals in crusts, which, upon being exposed to the atmosphere on linen cloth for several days, acquire an increased whiteness. This is the *crystal of tartar* of pharmacy, met with in the apothecary's shop as a powder, for greater convenience, and to which the name of *cream of tartar* properly belongs.

The cream of tartar of commerce is not a pure bitartrate of potash, as it very often contains from ten to thirteen per cent. of tartrate of lime (CaO,C_4H_2O), according to the analysis of Mr. J. M. Maisch. It is adulterated with such substances as sand, clay, gypsum, flour, chalk, alum, and sulphate of potash ($KOSO_3$). Sand, clay, and gypsum in tartar is detected by their not dissolving in hot water; iodine (I) will turn a solution of tartar a blue color if it contains flour; if chalk is present the solution will foam, by adding diluted acids to it; alum is detected by its astringent taste, and if it contains any sulphate of potash, it will precipitate by adding chloride of barium ($BaCl$) to a solution of the suspected tartar, and the precipitate will not be entirely soluble in nitric acid (NO_5).

The action of the last-named test is explained thus: the chloride of barium is not soluble in nitric acid, but the tartrate is. The best security against these frauds is to purchase the crystals, and grind them yourself. Cream of tartar is a permanent salt, and has a sour but not a disagreeable taste. It is soluble in one hundred and eighty-four parts of cold and eighteen parts of boiling water; it is insoluble in alcohol. It consists of two equivalents of tartaric acid, one equivalent of potassa, and one equivalent of water, thus:

2 equivalents of	tartaric acid, .	$C_8H_2O_{10}$	=132
1 "	potassa, . .	KO	= 47.2
1 "	water, . .	HO	= 9
			188.2

According to the above, its prime equivalent is 188.2.

TARTARINE.

A Substitute for Tartar.

There are numerous substitutes now in the market to take the place of tartar, such as "Tartarette," "Colorine," "Silver Tartar," "Tartar Mordant" (oxalic acid in combination with terra alba), and "Tartarine." We have tried them all, and after a fair and impartial trial, have come to a positive conclusion that there cannot be a substitute manufactured to come so near the *real article* itself as the tartarine. We have used it for over two years, with the very best results, on all colors where a tartar is required. As a substitute for tartaric acid, it is invaluable, having the same effects in all respects as the tartaric acid of commerce, and we have used it often in place of tartaric acid.

Tartarine contains one-third more tartaric acid in its com-

position than either cream of tartar or half-refined tartar; therefore we prefer it to either of the two last-named substances, and especially for coloring scarlets, as by its use there is a saving of cochineal; we have to use less of it to produce the same shade on the same amount of goods, than we would have to use provided cream of tartar or half-refined tartar was employed; it also requires less tartarine. In using tartarine, its proportions are one-third stronger than cream of tartar, or half-refined tartar; that is, it requires one-third less than the other named tartars. Tartarine springs the color from cochineal, logwood, and other red woods, to such an extent, that it requires less of them to produce the desired amount of color than it does when using argols in any of its prescribed forms, thereby making a saving of dyestuffs, and a clearer color. We knew of a number of dyers that, when they first used it, got "stuck" (as the saying is in the dye-house), for the very reason that they used as much of it as they used of cream of tartar, but after using it awhile, they have informed me that there was no substitute, not even tartar itself, that produced such good results as tartarine, and that they would not be without it as long as it can be obtained.

The above will be the verdict of every dyer who will give it an impartial trial. In the recipes on cloth and wool, contained in this work, the reader will find that wherever a tartar is required in the composition of the color, tartarine is used invariably, and by looking at the samples of cloth and wool, you will see that the colors are clear and intense — not *thin* and *dead* looking.

I would advise all dyers who have not used the tartarine to give it a fair trial, and my word for it, they will always thereafter use it.

Send for a circular of recommendations to Rollins & Ashley, No. 79 Bedford Street, Boston, Mass. They are the sole agents for it.

ALUM.

This is an earthy salt, and is extensively used in dyeing and calico-printing, in combination with other substances. In calico-printing and cotton-yarn dyeing, it is generally used in the form of an acetate of alumina, or the so-called red liquor. In woolen dyeing, it is used as a base or mordant for nearly all the different colors, along with tartar.

In the process of combining alum with wool, it has been shown by "Messrs. Berthollett, Thenerd, and Roard, that alum unites entirely with wool, without any decomposition of the salt, but that the tartar is deprived of its excess of acid, which unites with the alum and wool, leaving the neutral tartrate of potash in solution in the preparation liquor; so that a preparation of alum and tartar impregnates the wool with a salt composed of sulphuric and tartaric acids, potash and alumina."

The latest investigations on this subject were made by Havrez, who ascertained by his researches, that there should never be a larger amount of alum used than thirty per cent. of the weight of wool. Although this statement is given by so eminent a chemist, I must differ from it, and so will every practical dyer; for where is there a dyer that would ever attempt or think of employing thirty pounds of alum to one hundred pounds of clean wool to produce a green with fustic and sulphate of indigo, or a red with madder or camwood, or any of the red woods?

But independent of the effects of alum and tartar upon wool, as spoken of by Berthollett, which might be produced by any other acid, tartar appears to be capable of effecting a further object, by inducing a double decomposition, which transforms the alum into a tartrate of alumina. These results are brought about only at the boiling point; for if we should dip wool in a cold solution of alum and tartar, then dip it into boiling water, it would part with all the alum which it received in the cold bath; but when the wool is boiled in the alum and tartar

solution, it yields to this liquor a portion of its organic matter, which becomes dissolved; but, at the same time, the wool will absorb an equal amount of the alum. The presence of alum upon the wool, when we take it out of the preparation-liquor, is very evident, from the peculiar stain given to the wool; but the presence of sulphuric and tartaric acids, and potash, is only presumable.

The kinds of alum mostly met with now in the market, are the potash, ammonia, and natrona porous alum. Potash alum contains in 100 parts of—

Potash, ...	9.90
Alumina, ...	10.83
Sulphuric acid, ...	33.76
Water, ...	45.51=100

This alum is denominated a double salt, it being composed of two sulphates—the sulphate of alumina and sulphate of potash.

Potash alum crystallizes very easily; it will fuse at 92° in its own water of crystallization, leaving a colorless fluid, which remains a fluid for some time after cooling, before it solidifies into a crystalline mass. At a temperature a trifle below red heat, it will lose all its water, and become converted into burnt alum, a white porous and friable substance.

100 parts of water at 40° will dissolve 32 parts potash alum.
" " 100° " 360 " "

The solution of this alum in water has an astringent, sweet taste; a strong concentrated solution of it will destroy the blue color of many—if not of all—artificial ultramarines.

Ammonia alum contains in 100 parts—

"Ammonia, ...	4.90
Sulphuric acid, ...	35.09
Alumina, ...	11.90
Water, ...	48.11=100."

Ammonia alum is at the present time far more extensively manufactured than the potash alum. When this alum is strongly heated, the water, sulphuric acid, and sulphate of ammonia, are expelled, and alumina alone remains.

100 parts of water at 40° will dissolve 27.30 parts of this alum.
" " 100° " 42.10 " "

Natrona Porous Alum.

This alum contains more alumina than any other alum in the market, and, for that reason, it is so well adapted for a mordant on prints or plain-colored cotton fabrics.

All practical dyers are well aware that alum, of itself, is a feeble mordant for cotton, on account of the iron in combination with the acid and alumina; but the natrona being free from iron and ammonia, makes it a powerful mordant, when compared with any other of the alums.

This alum contains, in 100 parts, —

"Alumina,	18.90
Sulphuric acid,	36.50
Potash,	2.00
Water,	42.60=100"

The active principle of this alum is evidently the sulphate of alumina, and not the sulphates of potassa and ammonia, as is the case with all other alums. The preparation of alum is simply the obtaining of a definite compound, and, while it readily crystallizes, it can be obtained in a pure state, and especially free from iron, — a very injurious substance in alum, when used for calico-printing. The natrona alum, at the present time, is the only alum used for paper-making, in most, if not all the paper-mills in this country, on account of its being perfectly free from iron. The color of this alum is white. It is easily cut with a knife. It readily dissolves in water, and always contains free acid; also, to some extent,

potash. But, in a perfectly pure state, it contains no potash, and consists, in 100 parts,—

"Alumina, ...	18.78
Sulphuric acid, ...	38.27
Water, ...	42.95=100"

This is its composition in its purity. The formula of this alum, when pure, is $Al_2(SO_4)+18H_2O$.

The specific gravity of a concentrated solution of this alum is 1.530; of the alum itself, 1.760; while that of the English is 1.485, and of the alum itself, 1.695, showing quite a difference in favor of the natrona porous alum. The natrona alum is what I term a concentrated alum, and it requires one-third less of it than of any other to produce the same results; but, in using, I have found dyers that will use as much of it as they would of the lump alum; and then they say, "I do not like it, because it makes my reds too much upon the scarlet shade," &c. Now, if these dyers would use less of it than they would of other alums, they would not have any trouble in getting a good clear, bright, and full red. All dyers know, or, at least, should know, that an excess of alum causes the wool to feel harsh, and that it kills the soap when using it in the fulling and scouring of the cloth; therefore, when the fuller finds that he cannot get the goods clean by using a soap of two degrees of alkaline strength, he will add more and more alkali to the soap until it is strong enough to cleanse the cloth; then the dyer finds fault because they full or scour out his colors, and blames the fuller for it, when, if he would look at it in the right light, he would find that there was no one to blame but himself. I knew a dyer who used thirty-five pounds of alum on two hundred pounds of clean wool in saddening down, besides twenty-five pounds that he used in the preparation; and when asked why he used so much alum, "Oh," said he, "the alum will *kill* the *soap*, so that the fuller *cannot strip* the *color* down."

There is no alum so good for coloring yellows, oranges, crimsons, or reds on wool, as the natrona alum. It gives a brighter and more intense hue than any other alum in the market, besides the advantage of not having to use so much of it; therefore, it takes less strength of soap to cleanse the goods, and the goods feel softer, and the color is not injured by the use of strong soap.

For coloring-purposes, the most detrimental substance in alum is iron, and, to detect it, "dissolve some of the alum in distilled water; then add to it a few drops of dissolved red prussiate of potash; or boil some alum with a few drops of nitric acid; then add a few drops of dissolved yellow prussiate. In either case, if there is iron in the alum, the solution will turn to a blue color. Or dissolve some alum, as above, in distilled water; then add a few drops of gallic acid. This will turn the solution black, if there is iron in the alum. Or you can make a solution of a piece of alum; then add caustic potash to it until the solution is very alkaline; then boil this solution, and, if the alum contains iron, it will form at the bottom in a brownish, glutinous mass." Pure alum is all soluble in water.

We might give a detailed account of the different methods for the preparation of alum, but thinking that it would not be of any particular benefit to dyers, it will be omitted.

There is a chrome alum that is now obtained in large quantities, as a by-product in the manufacture of aniline-violet, aniline-green, and anthracene-red. It is a crystallized substance, of a deep violet color, and is now being, to some extent, used as a mordant. It is also used for waterproofing, repellants, or cloaking.

Aluminate of Soda.

This (what we may call a mordant) is now prepared on a large scale, as it has been found to be a useful form of soluble alumina, more particularly for cotton-dyeing and calico-printing.

The preparation of this substance is based upon the hydrate of alumina being so soluble in caustic potash, and also by the solution being so easily decomposed by acetic and carbonic acids, sal-ammoniac, and acetate of soda. It is also prepared from cryolite, which is deprived of its flourine by the addition of lime, and from an aluminate of iron. The iron is calcined with carbonate of soda; it is then washed, and evaporated to dryness.

By a certain amount of hydrochlorine acid (muriatic acid), the soda will be separated from the iron, and the hydrated alumina that is left is soluble in acetic acid, and contains, in one hundred parts, —

Soda, ...	44
Alumina, ...	48
Chloride of sodium and glauber salts, .	8=100

Aluminate of soda was first introduced to the notice of dyers in or about the year 1819, by Marquer and Haussmann, but their preparation being so very expensive it did not come into general use until within the last fifteen years, and now the Washington Chemicals Works in England prepare it at such a low price that cotton printers and dyers are finding it profitable to use it as a mordant. We find it in the market as a powder of a green-yellow hue, and dry to the touch. It is soluble either in hot or cold water. When exposed to the atmosphere, it absorbs moisture and carbonic acid, this salt being thus changed by the atmosphere; if it is then dissolved in water the solution becomes turbid, which is owing to the alumina being in suspension. A solution of aluminate of soda cannot be made stronger than 12° or 15° Baume, and from 1.7 to 1.09 specific gravity.

This salt is used for numerous purposes besides dyeing and calico-printing. Large quantities of aluminate of soda are manufactured at Natrona, Penn., and are used for making soap, and called *Natrona refined saponifier*.

Among the different salts of alumina that are industrially employed are hyposulphite of alumina, which was recommended by E. Kopp as a mordant for cotton; sulphite of alumina, for purifying beet-root juice; oxalate of alumina, suggested by Dent for the preservation of marble, stone, &c.; the hypochlorite of alumina, known as Wilson's bleaching liquor.

Alum, besides being used for dyeing purposes, is employed for the preparation of the lake-colors, there being active coloring principles in combination with alumina. Alum is used for hardening gypsum, in sizing for hand-made paper; the alum in this case forms with the glue or size an insoluble compound. Alum is used in clarifying turbid fluids, especially water; in this instance the alumina that is suspended in the water is taken up by the alum, the alum forming an insoluble (basic) alum, which carries down or precipitates the organic matters and other impurities which are in solution in the water.

A boiling solution of common salt, alum, and nitrate of potash is employed by jewellers for coloring gold, or, in other words, to produce a film of pure gold on the alloy; the copper alloy is dissolved by the boiling solution.

Alum is but a weak mordant for cotton, yarn, or cloth (unless it is converted into an acetate of alumina), owing to the sulphuric acid contained in the alum having so strong an attraction for the alumina, and in alum the sulphuric acid has three proportions to every two of alumina. But if a portion of the acid is neutralized there will remain only enough acid to hold the alumina in solution, which is not over one-third of the acid contained in the alum; by so doing the properties of the alum become greatly improved as a mordant. The amount of acid which will admit of being reduced can be found by taking a given quantity of carbonate of soda (sufficient to neutralize the whole of the acid in the amount of alum taken). Now divide this soda solution into three proportions and add two of these portions gradually to the alum

solution (stirring it all the time), and although the alumina will be precipitated, if the stirring or agitation is continued for a short time the precipitate will again dissolve. This forms an alum that contains not over one-third the acid that there is in the common alum, and in this state it is a more powerful mordant for cotton than it is in the original state, for the reason that the base is held more feebly by the sulphuric acid and is then more readily detached by the affinity of the yarn or fabric to form a mordant. Alum thus prepared is nearly, if not quite pure, the iron formerly present being precipitated by the process named above. Alum in this state is called cubical or basic alum, and is sometimes called neutral alum. The same salt can be produced by boiling twelve parts of alum and one part of slacked lime in water. This alum is often preferred to any other, as it does not affect certain colors.

Sulphate of Alumina.

There have been many attempts to introduce this substance in the practice of dyers, but they have not been successful until within a few years, as it contained so great an amount of sulphate of iron, and an excess of sulphuric acid in combination with the iron. This substance would not have an affinity for cotton unless these defects were overcome. However, at the present day, with improved methods of manufacturing it, sulphate of alumina is largely prepared, and it is of excellent quality. It is sold sometimes under the name of concentrated alum (which is erroneous), and is found in the market in square cakes of a white color and nearly transparent.

Acetate of Alumina.

The best and most common preparation of alum, as a mordant for cotton, is the acetate of alumina. The method of preparing it is given under the head of Mordants for Cotton, found in another part of this work.

SULPHATE OF INDIGO.

This substance is a combination of sulphuric acid and indigo, known by the different names of Saxon blue, extract of indigo, indigo paste, and chemic.

Dyers do not make their chemic now as much as in former years, it being found in the market, manufactured for them, and sold under the names of extract of indigo and indigo paste. When dyers made their sulphate themselves, each one had a rule or particular method of his own, some using four pounds of oil of vitriol to one pound of indigo, others three to one; but the best proportion, in my opinion, is to use seven pounds of acid to one pound of the indigo, especially for greens on wool; but for chemic to work with aniline blue and violet dyes, I prefer using more acid to the indigo, say eight pounds to one pound of indigo. It would be better for every dyer to make his own sulphate of indigo (besides costing his employer less for it); he would then know the correct amount of acid he was using, as well as the amount of indigo. Indigo when made into the sulphate of indigo, becomes radically changed, and there is nothing that can bring it back to its primitive state again, forming, as it does, a chemical compound, sulph-indigotic acid, called by dyers, extract of indigo. Concentrated oil of vitriol is the only substance that will dissolve indigo without destroying its color and composition; or, in other words, oil of vitriol is the only substance that will dissolve indigo without deoxidizing it, and it requires highly concentrated or fuming oil of vitriol for that purpose, as when other acid than the concentrated is used it requires a larger quantity of it to produce the desired combination; and where so much acid is used, the solution will have to be neutralized before it can be used with good results.

The action of sulphuric acid upon indigo was found by Mr. Crum to be more than a mere solution; it was a chemical combination, in definite proportions (and not a solution in the ordinary sense of the word), forming two very distinct sub-

stances, and greatly differing from each other in their properties. He named these two compounds, from their colors, *verulin* and *phinacin*, the latter purple and the former blue. Since this discovery they have been named sulpho-purpuric and sulph-indylic acids. The latter constitutes the blue principle of Saxon-blue, and is more abundantly formed if the sulphuric acid is sufficiently strong and abundant, and all proper care given to it while in progress of combining. Its composition is one atom of indigo in combination with two atoms of sulphuric acid. The former (sulpho-purpuric) is of a purple color, and if water is added to it, precipitation takes place. Its composition is equal; that is, it has one atom of indigo and one atom of acid.

By rigid examination and experiments, it was found that it required eight pounds of concentrated or fuming sulphuric acid to convert one pound of indigo into the blue sulph-indylic acid, this compound being the best of the two; and in making the sulphate of indigo, every care should be taken to convert the indigo into this compound, and so avoid the formation of the sulpho-purpuric acid. This latter substance is formed, in the first place, by using too small a quantity of sulphuric acid in proportion to the indigo employed; and in the second place, dyers are in too great haste in making it, thereby not allowing time for it to digest.

When the indigo is first added to the acid, there appears, to the eye, a solution of the indigo, almost instantaneous; but such is not the case; which is shown by spreading a few drops upon a piece of glass, when we perceive a dirty greenish color; and after remaining upon the glass for a short time, there will be a yellow-colored liquid running out from it. This yellow-colored liquid is no doubt caused by the acid absorbing moisture from the surrounding atmosphere, this moisture causing it to separate from the indigo, thus showing to us very clearly that there is not an immediate solution of the indigo, when it is added to the sulphuric acid. If the indigo used in this case is of a poor quality, the darker and

greener it will appear upon the glass; and after it has been mixed for a few hours, and then a few drops of it put upon a piece of glass, the same as before, we find that it has a purplish-red appearance; the greater part of the compound is sulpho-purpuric acid. Mr. Crum says that after the color of the solution has assumed a bottle-green, and it is then diluted with water, the action of the acid is stopped, and there is then formed the sulpho-purpuric acid. But there are other means besides diluting the acid with water, that will stop the action of sulphuric acid upon the indigo.

It has been already stated, that it requires a highly concentrated oil of vitriol to convert the indigo into sulph-indylic acid. We find dyers very often who change the strength of their chemic by the method of preparing or mixing it. They will mix it in the jar and leave it uncovered, thus allowing the acid to absorb moisture from the atmosphere; or, in some cases, they will put the jar into a tub of hot water, or place it on the top of the steam-boiler. By thus doing they cause the acid to absorb water very rapidly, thus diluting it below the required strength for dissolving the indigo, and causing the formation of the sulpho-purpuric acid, instead of the sulph-indylic acid, the latter being the real compound that is wanted.

As already stated, the sulpho-purpuric acid is formed, in one instance, by the dyer putting the jar or vessel, in which he has mixed his acid and indigo, into a tub containing boiling water. Sometimes, in making chemic, the heat of the mixture becomes so low that it does not promote the chemical action whereby the combination of the acid and indigo can be effected; in this case putting the vessel into hot water would not form sulpho-purpuric acid; that is, if care is taken not to allow the hot water to heat the solution above the boiling point.

In speaking of the causes of stopping the action of the acid upon the indigo, there is another cause for it, and that is the indigo itself. We know that ground indigo will absorb a

quantity of moisture, and this moisture will necessarily dilute the acid when the indigo is added to the acid; therefore, it should be thoroughly dried by some means or other, before adding it to the acid, or the acid will be too much weakened to produce or form sulph-indylic acid, the substance we want.

Sometimes the indigo is added all at once to the acid, which causes a great evolution of heat, thereby decomposing the impurities contained in the indigo, and a part of the acid is also decomposed, giving off a large amount of sulphurous gas. Indigo that is treated in this manner very seldom makes good chemic, and when a few drops are placed upon a piece of glass, it has a blackish-green appearance, sometimes a dirty purple color, but seldom the blue violet, and very rarely the fine beautiful blue.

The sulpho-purpuric acid contained in the sulphate of indigo is precipitated when the sulphate of indigo is diluted with water, the sulpho-purpuric acid dissolves in alkalies, and gives a blue color, of a greater or less purity, according to the alkali employed as the solvent.

The dyer now very seldom prepares his own chemic, it being manufactured for him, and sold by the name of extract of indigo. The following is the process of its preparation:—

The indigo is dissolved in concentrated sulphuric acid (different manufacturers using different proportions). It is then diluted with hot water. The whole is put upon a filter of woolen cloth, which separates the insoluble impurities of the indigo. The solution which has passed through the cloth, is put into a leaden vessel, and there evaporated to about three gallons for every pound of indigo used. There is then added to it from three to four pounds of salt to the pound of indigo, and then well stirred up (by this means all the sulpho-indylic acid is precipitated). The whole is then thrown upon another filter of woolen cloth. There it remains until it has drained sufficiently. It is then put into earthen jars, ready for sale, and is called *extract of indigo.*

Some makers put soda and a little ammonia into the extract, which gives it that bloomy appearance we sometimes see. A pound of good indigo will make about fourteen pounds of extract, if proper care and management are taken in the preparation of the *extract*. There are various adulterations to sulphate of indigo, Sometimes insoluble matter is added, but not often, as it injures the appearance of the extract, and those makers who do it, are the losers by the operation; for although the dyer may not have the facilities to test the extract, he will very soon ascertain by experience the working value of it. Some makers add lime and barytes to their extract, which gives an insoluble precipitate, and adds weight to the extract; but this practice generally re-acts upon the maker, and he is the loser rather than the gainer by the operation.

The method that I adopt for making this article is as follows: —

In the first place, I endeavor to obtain the very best ground indigo. Then dry it as much as possible by placing it either on the top of the boiler, or in the dry-house. Then, for every pound of indigo that I intend to use, I take seven pounds of concentrated oil of vitriol, using a glazed earthen jar, adding the indigo gradually (say about one-half at a time), stirring it all the time, until the indigo is all thoroughly moistened by the acid. Then, in the course of fifteen or twenty minutes, add the remainder of the indigo, stirring it as before, and stir it during the day at intervals. Do not use it until it is two or three days' old. When making the sulphate, do not set the jar in the dye-house, where it will absorb moisture from the steam and vapors arising from the various dye-tubs. The jar should be kept covered, and placed where the heat (caused by the combination of the acid and indigo) can be kept at 160° F. As the combination takes place, the compound will assume a frothy appearance; will increase in volume, and a great deal of heat is generated, with the disengagement of sulphurous acid gas. These are the

certain results of the combination; and when they have ceased, the chemical union is completed. Sulphate of indigo does not give a permanent color; yet it can be made to resist the alkalies and the fulling process very well, by mordanting the wool or cloth with bichromate of potash, alum, and tin crystals (see Recipes for Greens, in another part of this work).

Crystallized Acetate of Lead (in Crystals, $PbO,C_4H_3O_3 + 3HO$), or, Sugar of Lead ($PbO,C_4H_3O_3$).

This salt is composed of—

Oxide of lead, . . .	58.71,
Acetic acid, . . .	27.08,
Water, ...	14.21, in 100 parts.

Sugar of lead is manufactured by exposing the metallic lead to the action of rectified or wood vinegar (acetic acid), and to the atmosphere. The lead decomposes the acetic acid, forming carbonate of lead. This carbonate is then easily decomposed by adding more acid to it, which combines with the carbonate of lead, forming acetate of lead, and the carbonic acid is all evolved. This is not the only method adopted to prepare sugar of lead. Some makers immerse sheets of lead in a wooden tub containing vinegar, so constructed that the upper sheets will be exposed to the action of the atmosphere. The action of the air causes a crust of carbonate to form on the sheets of lead thus exposed. Then these sheets are put to the bottom of the tub, and those at the bottom to the top, where they will be exposed to the same course of action. This shifting the sheets from the top to the bottom is for the purpose of allowing the acid to decompose the carbonate formed upon the lead. This decomposition forms the acetate of lead. Another process is to allow vapors of vinegar to pass over sheets of lead, and the carbonate that is formed by the vapors is collected or scraped from the sheets, and then put into a tub containing strong vinegar; and in both of these

processes, when the vinegar ceases to decompose any more of the carbonate, it is then drawn off into tinned copper pans, or wooden tubs, and allowed to crystallize. Acetate of lead is also prepared by boiling litharge in wood vinegar in a leaden boiler, constantly being stirred, in order to prevent the litharge adhering to the sides and bottom of the boiler. When a proper amount of litharge is dissolved, there is then enough cold water added to the solution to cool it down just below the boiling point. After the solution has settled, the clear liquid is drawn off into proper vessels, where it is left to crystallize.

All the difference in making the white and brown sugar of lead, is that, for the white, the solution is filtered through bone-black before it is set away to crystallize. The best acetate for coloring oranges, amber-color, and deep yellows on cotton-cloth or yarn, is that which is composed of three parts of lead to one part of acid in its combination. It is prepared in the dye-house by boiling sugar of lead and litharge together, and adding a very small quantity of lime, different dyers using different proportions. One hundred parts of litharge will yield one hundred and fifty parts of acetate of lead. Acetate of lead is not used in woolen-dyeing, but is largely used in cotton-dyeing and calico-printing, in making acetate of alumina, chrome-yellow, and chrome-orange. It is also used to make varnishes.

Acetate of lead, when submitted to dry distillation, yields neutral carbonate of lead and acetone, which will volatilize. When heated with sulphuric acid, it yields acetic acid, sulphate of lead remaining in the retort.

Acetate of lead is extensively manufactured in Germany, Holland, France, England, and in the United States. It is principally consumed in the art of dyeing and calico-printing, in which it is employed to form with alum the acetate of alumina. Its taste is at first sweet, and afterwards astringent. When exposed to the atmosphere, it effloresces slowly. It dissolves in four times its weight of cold water, and in a

much smaller quantity of boiling water; it is also soluble in alcohol. Its solution in water is turbid, in consequence of the formation of carbonate of lead with the carbonic acid always found in river-water; but this turbidness can be removed by adding a small proportion of vinegar or diluted acetic acid to the water. In pure distilled water it ought to entirely dissolve, and leave a clear solution.

As it is found in commerce, it contains as impurities, sulphate and carbonate of lead. "Mr. John Mackay of London, analyzed a sample of acetate of lead obtained in the London market, which contained nearly thirty per cent. of sulphate of lead" ($PbSO_3$). Sulphuric acid, when added to a solution of acetate of lead, will produce instantly a precipitate of sulphate of lead, and the fumes emitted have the odor of vinegar, which is owing to the disengaged acetic acid.

An important property of sugar of lead is its power of dissolving a large quantity of litharge.

Acetate of lead consists of one equivalent of acetic acid, 51.0; one equivalent of protoxide of lead, 111.5; and three of water, 27.0; making its prime equivalent=189.5, and its formula ($PbO,C_4H_3O_3+3HO$).

PROTOXIDE OF LEAD (=PbO), OR LITHARGE.

This substance is composed of equal proportions of lead and oxygen, and is obtained as a bi-product of the separation of silver from lead; it is also obtained by exposing metallic lead, when at a red heat, to a current of air; the oxygen of air combining with the lead, converts the lead into a semi-fluid mass; when this mass cools, it forms crystals of a greenish-yellow color. When this oxide of lead is kept a few months, it falls into a scaly crystalline powder, and has a brick-red color. This is the principal oxide from which acetate and other salts of lead are prepared for use in the

dye-house. Litharge always contains more or less oxide of copper (CuO), oxide of antimony (Sb_2O_3), and traces of oxide of silver (Ag_2O_3); it also contains metallic lead, varying in amount from one and one-fourth per cent. to three per cent. The oxide of copper can be removed from it by digesting the litharge with a solution of carbonate of ammonia ($(NH_4)_2C_2O_3$), the solution to be cold. Litharge, when good and not adulterated, will have a crystalline lustre, and will become completely soluble in nitric acid. The adulterations of litharge are, generally speaking, brick-dust, iron, and copper. These can be detected by digesting the litharge in nitric acid; and if brick-dust is present, it remains insoluble and will be apparent, and by adding ammonia to the solution, the litharge is precipitated, and the precipitate will be of a brown color; and if it contains copper, the solution will be blue-colored. But these adulterations are not injurious to it, for the purposes for which it is used in the dye-house.

Litharge is not employed in woolen dyeing. It is employed in cotton-dyeing and calico-printing for making acetate of lead. (See Recipes for making Lead Solutions.)

The fine-powdered litharge sometimes met with in the trade, is very often adulterated with sulphate of barium ($BaSO_4$), which can be detected by dissolving some of the litharge in diluted nitric acid, but the small scale litharge cannot be very easily adulterated. The English litharge is considered the best, that from Germany being generally contaminated with iron and copper. In choosing litharge, samples should be selected that are free from copper, and fragments of vegetable matters. There are two varieties of litharge, called the gold or red litharge, and the silver or yellow litharge. The former kind is said to owe its color to a portion of red lead being in the litharge, but M. Leblanc has shown that the two varieties differ only in color, structure, and density, and not in their chemical composition. "Red lead can be detected in litharge by heating it in a test-tube, with chloride of sodium (salt) and bisulphate of potassa, and then putting in a piece of paper

colored blue by indigo; if red lead is present in the litharge, the paper will be bleached by the chlorine evolved."

SULPHATE OF COPPER, CUPRIC SULPHATE ($CuSO_4$), OR BLUE VITRIOL ($CuOSO_3+5HO$).

There are numerous methods of preparing this salt: —

First. One method is to heat sheets of copper (Cu) in a reverberatory furnace to the boiling point of sulphur (420° Fahr.); there is then a quantity of sulphur thrown into the furnace, the openings and flues of the furnace being closed; the result is the formation of sulphide of copper (Cu_2S). This sulphide is converted, by a low heat and the action of the oxygen of the air, into the sulphate of copper. The mass is then placed in stone troughs and oil of vitriol is added in sufficient quantity to saturate the oxide of copper (CuO); the clear solution is taken out and set aside for crystallization.

Second. The crude copper obtained from smelting the ore, which contains about sixty per cent. of the metal, is treated with sulphuric acid. This solution is evaporated in leaden vessels and the clear liquid is put into copper pans to crystallize. From the mother-liquor left from the crystals, metallic copper is precipitated with iron, there being large quantities of iron in this mother-liquor; it is then unfit for using again to make sulphate of copper. This last method of preparing blue vitriol is the least expensive, but it is not quite pure, and, according to M. Herter's analysis, it contains about three per cent. of sulphate of iron and 0.083 per cent. of metallic nickel.

This salt is also prepared or manufactured in the same manner as copperas (protosulphate of iron, SO_4Fe); that is, from the sulphurets of the metal.

A chemically pure sulphate of copper is made by heating the

metallic copper with highly concentrated oil of vitriol, the copper becomes oxidized by a portion of the oxygen of the acid and sulphurous acid escaping (SO_2). Charcoal would produce sulphurous acid if heated with sulphuric acid.

If the metallic copper was converted into the oxide of copper (CuO), by being brought to a red heat first, it would then require but half the quantity of sulphuric acid. In preparing the base for the different pigments obtained from copper, the sulphate of copper is very often used; but it should be nearly pure, or should not contain either the sulphate of zinc or iron.

Sulphate of copper yields blue crystals (hence the name blue vitriol); these crystals contain five parts of water; four of them will be given off if they are heated to 212° Fahr., and at this temperature they become white. Blue vitriol is soluble in twice its weight of boiling water and four times its weight of cold water. It is composed of—

Sulphuric acid, ...	32.14
Oxide of copper, ...	31.79
Water, ...	36.07=100

The crystals effloresce in a dry atmosphere and become a white powder. Blue vitriol is insoluble in alcohol. Blue vitriol in crystals, as received by dyers, has a rich, deep, clear blue color and a strong metallic taste. It reddens blues produced by vegetable dyes. It is soluble in four parts of cold and in two parts of boiling water. When heated it first melts in its water of crystallization and then dries and becomes white. If the heat is increased, it next undergoes the igneous fusion, and finally, at a high temperature, loses its acid, protoxide of copper (CuO) being left.

Sulphate of copper is decomposed by the alkaline carbonates, and by borax, acetate, and subacetate of lead, acetate of iron and chloride of lime; it is also precipitated by all astringent vegetable decoctions. If it becomes very green upon

the suface, by being exposed to the air, it contains sesquioxide of iron (Fe_2O_3). This oxide may likewise be detected by ammonia, which will throw it down along with the oxide of copper without taking it up when added in excess.

Sulphate of copper consists of —

One proportion of sulphuric acid, . .	=40.00
One proportion of protoxide of copper, .	=39.75
Five proportions of water, . . .	=45.00=124.75

Making its prime equivalent 124.75; but, according to Berzelius, it is 124.7.

Chloride of copper ($CuCl$) is prepared by killing muriatic acid with copper, this causing a double decomposition to take place, the solution being of a green color; this solution can be crystallized, and the crystals are blue colored.

Nitrate of copper ($3HNO_33Cu$) is prepared in the same manner as nitrate of iron; that is, nitric acid is killed with copper; the action will be the same with each of the metals. Nitrate of copper, by evaporation, produces deep blue-colored crystals; they are deliquescent in the atmosphere and are very soluble in water.

Acetate of Copper, Verdigris ($C_2H_3O_2Cu$).

This was formerly prepared by exposing sheets of copper to the action of vinegar (acetic acid, $C_4O_4H_2$). This salt we find in dark-green crystals, containing one part acid to two of copper. The manner of preparing it at the present day, for calico-printing and dyeing, is as follows: —

Take four pounds of blue vitriol, dissolve it in four quarts of water; then dissolve three pounds of white sugar of lead in one quart of water; mix these two solutions together; let it settle, and use the clear solution only. This should indicate 18° Baume. The mixing of the lead and copper solutions causes a double decomposition to take place, the result being crystals, or crystallized verdigris; the verdigris paste

having a blue color, being a basic salt called French verdigris, and is but up in leather bags and pressed into cakes.

YELLOW PRUSSIATE OF POTASH.—(Ferrocyanide of Potassium, $K_4FeCy_6+3H_2O$).

This salt, in a technical point of view, is a very important substance. It crystallizes in large lemon-colored prismatic-shaped crystals. These crystals are not affected by exposure to the atmosphere, neither are they poisonous; they have a sweetish-bitter taste; they dissolve in four times their weight of cold water, and twice their weight of boiling water; but they are insoluble in alcohol. They contain in 100 parts,—

Potassium,		37.03
Cyanogen	Carbon,	17.04
	Nitrogen,	19.89
Iron,		13.25
Water,		12.75

At 100° Fahr., the water is driven off.

This salt is prepared on a large scale by burning hoofs, horns, hides, old woolen rags, and all such substances as contain nitrogen, with carbonate of potash (K_2CO_3). The quantity of the materials may be varied; the relative proportions are given by some manufacturers as one hundred parts of carbonate of potassa (potash) to seventy-five parts of the nitrogenous carbon. Runge gives as his method, one hundred parts of carbonate of potassa, four hundred of calcined (burnt) horn, and ten of iron-filings. As a general practice these substances are burnt in a cast-iron cylinder or a reverberatory furnace, before being mixed with the carbonate of potash; but if these substances are used before being calcined, they are mixed in the ratio of nine of the charcoal to

one of the potash; but if the substances are burned as above-mentioned, one and a half parts of the charcoal are mixed with one part of potash.

When the nitrogenous carbon (animal matters) is used without the process of being previously charred, the furnace is left open, so that the materials can be occasionally stirred, which allows the obnoxious gases to escape, after which the furnace is closed and the heat is increased. The heat is continued for some fourteen hours, and at intervals of one hour the furnace is opened and the materials are stirred. They continue this stirring until no flame rises to the surface, and the whole is reduced to a red, semi-fluid mass.

The whole mass is then scraped out of the furnace and allowed to cool; after cooling it is dissolved in water and the solution filtered through cloth, and then evaporated to a proper consistency; coarse strings are now suspended throughout the liquid; upon these strings the crystals form, of a lemon-yellow color.

The theory of the formation of yellow prussiate of potash is as follows: "The carbonate and sulphate of potash, the nitrogenous coal and the iron re-acting upon each other, give rise to the formation of sulphuret of potassium, which in its turn converts the iron into sulphuret, while the nitrogen contained in the charcoal unites, under the influence of potassium, with the cyanogen of the carbon, which again in its turn combines with the potassium, giving rise to the formation of cyanide of potassium (KCN)."

"When the fused mass is treated with water, cyanide of potassium (KCN) and sulphuret of iron (SFe) decompose each other, the result being the formation of ferrocyanide and sulphide of potassium, the sulphide remaining in the mother-liquor."

Yellow prussiate of potash is employed for the preparation of red cyanide or prussiate for making Berlin blue, and of cyanide of potassium. It is used in calico-printing and cotton-dyeing (seldom in woolen-dyeing) for producing blues (see

recipes for cotton-yarn), and some brown-red colors, and for the purpose of hardening iron, and as an ingredient in white gunpowder, and for use in chemical laboratories.

Yellow prussiate crystallizes with three proportions of water, but loses all its water of crystallization at 212° Fahr., and becomes white.

Ferricyanide of Potassium, or Red Prussiate of Potash (K_3FeCy).

This salt is prepared on a large scale, and is very extensively used in dyeing cottons and in calico-printing; it is also used to a great extent in the woolen dye-house. This salt crystallizes in prismatically-shaped ruby-red colored anhydrous crystals, and consists in 100 parts of—

Potassium,		35.58
Cyanogen	Carbon,	21.63
	Nitrogen,	25.54
Iron,		17.29

There are two methods for preparing this salt. One is: The yellow prussiate is dissolved in water; then the solution is submitted to the action of chlorine gas, until a sample of the solution will, when heated, show no precipitate if a per-salt of iron is added to the solution; after which it is evaporated and then crystallized. Another method is to pulverize the yellow prussiate and place it in casks, closed, so as to leave only a small outlet, while the cask can by means of machinery be slowly turned on its axis, so as to bring all the particles of the prussiate in contact with the chlorine as it passes through the cask. Sometimes the powdered yellow prussiate is placed on shelves in a chamber, and into this chamber at the top chlorine gas is admitted; after the powdered prussiate has become saturated with the gas (it is then still in a dry powder), it is taken and dissolved in the smallest possible amount of water, then this solution is allowed to crystallize; the liquid left after

crystallization contains chloride of potassium (KCl). The powdered red prussiate of potash is an orange-yellow color, and if sulphuric acid is mixed with this powder it will deprive it of its color, but by absorption of moisture it will turn back to its color again. According to M. E. Reichart's investigations, bromine can be successfullly used instead of chlorine for the preparation of this salt.

Red prussiate is soluble in the same amount of water that the yellow prussiate is.

Bichromate of Potassa — Acid Chromate, or Chrome ($K_2Cr_2O_7$).

This salt is prepared from yellow chromate, which is produced by the following method :—

"Chrome iron ore, after being ground and sifted, is mixed with dried nitrate and carbonate of potash. This mixture is put into a reverberating furnace, and a powerful heat applied. It is stirred occasionally, and when perfectly calcined, the mass is raked out and dissolved in water. It is then boiled for some hours. After it has done boiling, it is allowed to settle, and the solution is decanted; this is evaporated, and leaves the yellow chromate of potash crystallized." The chemical changes which take place are these: "First, the decomposition of the nitre giving off oxygen, which combines with the oxide of chromium, and forms chromic acid. This acid then unites with the potash of the nitrate and of the carbonate, and this forms the yellow salt, which is soluble in water. It contains soluble impurities, such as caustic potash, silicate, and aluminate of potash; these impurities are separated by the operation of boiling and crystallization."

"Bichromate is obtained from the yellow salt, described above, by the addition of acetic and sulphuric acid to a concentrated solution of yellow chromate. This last named acid is not well adapted for the purpose, as the sulphate of potash formed by the sulphuric acid is very difficult to separate from the chromate, and is a serious adulteration; for which reason

sulphuric acid is not now used as much as formerly. Acetic acid is the best, and is now, as a general rule, employed."

When acetic acid is used, there is just a sufficient quantity of it added to combine with one-half of the potash contained in the yellow chromate, which leaves two proportions of chromic acid (H_2CrO_4), in union with the other half of the potash, and may be thus expressed :—

$$\left.\begin{array}{c} 2K_2CrO_4 \\ \text{Yellow chromate.} \\ K \\ \text{Potash.} \end{array}\right\} \text{Bichromate of potash.}$$

$$\left.\begin{array}{c} 1C_4O_3H_3 \\ \text{Acetic acid.} \\ K \\ \text{Potash.} \end{array}\right\} \text{Acetate of potash.}$$

If sulphuric acid was used, and no acetic acid, it would be expressed thus :—

$$\begin{array}{ccc} 2K_2CrO_4 & + & H_2SO_4 \\ \text{Yellow chromate.} & & \text{Sulphuric acid.} \end{array}$$

$$\begin{array}{ccccc} K_2SO_4 & + & H_2O & + & K_2Cr_2O_7 \\ \text{Sulphate of potash.} & & \text{Water.} & & \text{Bichromate of potash.} \end{array}$$

When bichromate of potash has been prepared with sulphuric acid, it contains sulphate of potash to a great extent, which is detrimental in its application as a mordant for colors on wool or woolen fabrics. The sulphate of potassa can be detected, by dissolving a small quantity of bichromate in some distilled water; then add to the solution a very little of concentrated nitric acid, and then a few drops of either nitrate or chloride of barium, which will throw down a white precipitate, if there is any sulphate of potash in the chrome. The chloride of potassium can be detected by the above operation, only substituting nitrate of silver in the place of the barium; the result will be a white precipitate. "When acetic acid alone is used in a concentrated solution of yellow chromate,

the bichromate that is formed does not have as much water as will hold it in solution, therefore it is precipitated as an orange-colored powder. This powder is collected carefully, and dissolved and crystallized by slow evaporation." "Bichromate is soluble in three times its weight of cold water, and an equal weight of boiling water." A solution of chrome is very caustic and poisonous. When heated to redness, this salt gives off oxygen, leaving the oxide of chromium and neutral chromate of potash in the retort.

In the year 1820, M. Koechlin discovered the applicability of bichromate of potash as a "discharge" for Turkey-red, produced from madder (the coloring-matter of that color), a discovery soon followed by others, the useful application of bichromate for preparing the chrome-yellow and chrome-orange in calico-printing, the chrome-black in dyeing wool, the discharge for indigo-blue and the oxidation of catechu, the bleaching of palm-oil and other fatty matters, the preparation of chromic oxid for green pigments for painting glass and china, and for the preparation of *vert Guignet*, a peculiar hydrated oxide of chromium, obtained by heating one part of bichromate of potash, and three parts of crystallized boric acid, which is used as a pigment in calico-printing."

As might be expected, these discoveries gave an impulse to the preparation of the different chromates of potassa which have of late years found useful applications in extracting colors from coal-tar, and also in the manufacturing of chlorine gas.

According to Mr. J. Persoz, there is, America excepted, but five manufactories of the chromates of potassa; viz., two in Scotland, one in France, one in Norway, and one in Russia; and the total production of these works in 1869 amounted to 60,000 cwt.

In order to test for the strength and quality of bichromate of potash: "Take one hundred and sixty-five grains of pure nitrate of lead, and dissolve it in two hundred measures of water. This should precipitate seventy-four grains of bichro-

mate (if it is pure), so that all that is required, is to dissolve the chrome, then add the nitrate of lead as long as any precipitation takes place. If all the lead is required, the chrome is good; but every three graduations of the lead solution left, after precipitating the chrome, will represent about one per cent. of impurity of the bichromate."

The adulterations in chrome for the last few years, have been muriate of soda (salt).

PROTOSULPHATE OF IRON, OR COPPERAS ($=FeOSO_3+7HO$).

This salt is met with in the trade in the form of green-colored crystals, having an inky, astringent taste, and by exposure to a dry atmosphere, the crystals will effloresce, and be converted into a white powder. Dissolve this powder in water again, and we find it to contain both the persulphate and protosulphate of iron, or the basic sulphate of peroxide of iron. One hundred parts of the chemically-pure copperas consists of—

Sulphuric acid, ...	28.77
Protoxide of iron, ...	25.89
Water, ...	45.34=100

This substance is manufactured in various ways, and from various substances. The original method was by lixiviation of iron pyrites, or iron containing minerals. These minerals are collected and placed in layers on inclined platforms; then water is sprinkled upon these layers from time to time. As this water drains through the pyrites, they become soluble, and part of their substance is carried off, and is slowly oxidized by atmospheric agency. The water, after draining through, is received into stone cisterns, and taken from the

cisterns to the evaporating-pans, where it crystallizes. Copperas is also obtained as a by-product of alum-manufacture, by evaporating the mother-liquor containing iron. The brown sulphuric acid, or chamber-acid, as it is called, also such waste sulphuric-acid liquids as are obtained in the oil and petroleum refining, are sometimes used as solvents for scrap-iron to prepare copperas. It can be made by boiling the fine pulverized puddling, and iron-refining slags with sulphuric acid.

The English copperas is made from iron pyrites, as already described. These iron pyrites are a bisulphuret of iron (FeS_2), and contain, in one hundred parts, forty-eight parts of iron, and fifty-two parts of sulphur. These pyrites, when obtained from the older geological formations, are subject to spontaneous decomposition when exposed to moisture and the atmosphere, and the sulphur which they contain combines with the oxygen of the atmosphere, and thus forms sulphurous acid (SO_2), and will again, in the presence of oxide of iron and water, take up more oxygen, and then it is sulphuric acid, which, in turn, combines with the iron, forming, by crystallizing it, copperas.

The pyrites are collected and made into large heaps, and set on fire, in the same manner as they do with the alum-shale in the process of preparing it for the manufacture of alum. This roasting-process creates a quick oxidation of the sulphur, and the result is the formation of the sulphate of iron. This sulphate is then dissolved, by allowing water to pass through these heaps, and collected into tanks. In this solution there is always an excess of sulphur over the iron. There is also in it a per-salt of iron, with an excess of acid, and, very often, small quantities of copper, which would be very deleterious to the copperas. In order to get rid of the copper, a quantity of old rusty iron is thrown into the solution, which will precipitate the copper, and, at the same time, take up the excess of acid from the solution. It also reduces all the persulphate that it contains into the state of protosul-

phate. After this reaction has taken place, the solution is then evaporated and crystallized. But this adding old iron to obtain the changes above described not being adapted in all cases, is the reason we have the different varieties of copperas in the trade. The quality of the copperas is judged of, by most dyers, by its color, and the poorest is sometimes made to appear better than it really is by sprinkling upon it some lime, or a solution of salt, in order to give it a dark tint, which deceives the eye, but does not improve its quality in the least.

There is in the market a number of brands of copperas, — such as the English, Vermont, Keystone, and the Pillar copperas. The English is superior to the Vermont or Keystone, but I do not think it superior to the Pillar, as the Pillar is the very best that I have used, and, according to analysis, it is nearer to the chemically pure, in regard to the amount of sulphate of iron it contains, than either of the others.

M. Bansdorff states that there are three kinds, or varieties, of copperas, and classes them as the greenish-blue, dirty-green, and emerald-green, — the first being formed from an acid solution, free from the peroxide of iron; the second, from a neutral solution; and the last, from a solution largely impregnated with the peroxide.

M. Dumas states that these variations are the formation of a double salt of the *proto* and *per* sulphate during the decomposition of the pyrites. Copperas that is crystallized from a neutral solution, when kept for any length of time, will have a rusty appearance, which is caused by the absorption of oxygen. In the trade, there are two varieties mostly met with. They are the dark colored, and the very light green. The dark colored is better adapted for saddening purposes than the light green, but the latter is the best to use in the copperas-vat; the Keystone copperas being a light green, and containing a large amount of water of crystallization, would be the best for the copperas-vat.

The difference between the keystone, or light-green, watery-

colored copperas, and the dark-green colored, has been found to be about fourteen per cent. in favor of the dark-colored; or one hundred pounds of the dark-colored is equal to one hundred and fourteen pounds of the light green. As this light-green watery copperas, according to Bransdorff, is crystallized from an acid solution, we may infer that the combining of the extra proportion which it contains with the crystals, is owing to a portion of the mother-liquor being mechanically combined with the crystals, but it does not form an essential ingredient in the composition of the copperas; and should the copperas be crystallized from the sulphate of alumina contained in the solution, we find that the excess of acid will be more abundant. The presence of alumina in copperas can be detected by dissolving some of the copperas in water, and then boiling it. Then add a few drops of nitric acid to it, so as to deoxidize the iron contained in the solution; and if it contains alumina, the solution will be of a clear amber-color. Then to the solution add caustic potash to excess, or until the solution becomes very alkaline. Now boil it for thirty minutes, and filter it, and all the peroxide of iron will be found upon the filter, and the solution will contain all the alumina. Now add a little ammonia to the filtered solution. The result will be a flocculent white precipitation, if the copperas contains any alumina. If you should add aqua ammonia to the peroxide of iron which was left upon the filter, the ammonia, after passing through the filter, will be a blue color if the iron on the filter contained any copper. But if you wish to make a test for copper, it is best to do it separately, which is done thus: Dissolve the copperas as described above; then add a little nitric acid to peroxidize it. Add ammonia instead of caustic potash. Then filter, and the solution will be blue if there is the slightest trace of copper in the copperas. Copperas can be made by any dyer very easily, by diluting sulphuric acid with four parts of water, and adding iron scraps to it. The iron will soon dissolve, causing a rapid evolution of hydrogen gas. After the acid has eaten up all the iron it

can, then the solution must be evaporated by heat until you perceive a thin skin upon the solution. Then set it away in some cool place, and in a short time there will be formed a quantity of green-colored crystals of sulphate of iron, and they contain about seven proportions of water; or, in other words, these crystals contain, in 100 parts, —

Sulphate of iron, .	$FeSO_4$	54.05,
Water, . . .	H_2O	45.05=100.

When the crystals are heated to 242° F., they will part with all this water, with the exception of about ten per cent., and will lose their green color, and become white, as stated previously.

Copperas is very soluble in water. Cold water dissolves one-half its own weight; and one gallon of boiling water will dissolve thirty pounds of it.

The following is the composition of copperas in 100 parts :—

	English.	Vermont.	Chemical Pure.	Pillar.
Sulphuric acid, . . .	23.29	30.54	28.77	29.14
Protoxide of iron, . .	21.83	23.49	25.89	25.74
Peroxide of iron, . .	1.18	1.28	–	1.07
Water, ...	53.04	43.18	45.34	44.05
Oxide of copper, . .	–	1.51	–	A trace.
	100.	100.	100.	100.

Copperas is employed for other purposes besides use as a mordant for dyeing and calico-printing. It is used as a disinfectant, for making ink, for the deoxidation of indigo (in the copperas-vat), in gas-purifying, in the precipitation of gold from its solutions, in the preparation of Prussian blue, in the manufacture of fuming (Nordhausen) sulphuric acid; also for a host of other purposes.

Copperas consists of one equivalent of sulphuric acid = 40,

one of protoxide = 36, and seven of water = 63, making its prime equivalent 139, and its formula is FeO,SO_3+7HO, but often written thus, SO_3Fe, or $FeSO_3$.

SODA, OR SODIUM CARBONATE (Na_2CO_3).

Its composition in 100 parts is 58½ parts soda, 41½ parts of carbonic acid; otherwise, 58.5 soda, 41.5 carbonic acid.

Soda was not distinguished from potash until near the middle of the eighteenth century, when their different characters were recognized.

Before that period the potash was called the vegetable and the soda the mineral alkali.

In 1807, Sir H. Davy demonstrated that soda, as well as potash, was the oxide of a metal which he named sodium. The soda commonly used is derived from the three following named sources:

First. Natural or native soda.

Second. From plants.

Third. Chemical productions.

We will notice only the second and third sources from which we obtain soda.

Soda from Plants.

It has been found that the ash from plants, especially such as are grown at a considerable distance from the ocean, contains a large amount of carbonate of potash; also, that plants which grow near the seashore, and in the localities known as salt steppes, yield an ash that contains more or less soda, in the living plant combined with sulphuric and organic acids, and which, under the influence of the carbonate of lime ($CaCo_3$), is, during the ignition or burning of the plant, converted into carbonate of soda.

The plants from which soda is prepared are called *salsola*,

atriplex, *salicornia* and *kelp*. The process of obtaining soda from these plants consists simply in burning them in holes or pits made in the sand near the seashore. The heat of the burning plant becomes so intense that it causes the ashes to flux, so that after it becomes cold the substance will form into a hard, slag-like mass, which is termed crude soda or soda-ash, and the amount of carbonate of soda that it contains will vary from five to twenty-five per cent.

From these different plants, and the methods adopted to obtain the soda, we find the following kinds:

First. The barilla from Alicante, Malaga, the Canary Islands, and the barilla soda from the Spanish coast, contains, on the average, from twenty to thirty per cent. of carbonate of soda.

Second. Salicor, or soda from Narbonne, which is obtained by burning the plant *salicornia*, this plant being cultivated purposely, and gathered when the seed has become ripe. The soda from this plant contains about fourteen per cent. of carbonate of soda.

Soda Prepared by Chemical Processes.

One method of obtaining soda by chemical means is as follows: A furnace or muffle is well heated, then eight or ten hundred pounds of salt is thrown in, to which is added oil of vitriol; the quantity of acid is regulated so as to leave from one to three per cent. undecomposed, in order to obtain a perfectly neutral sulphate. One hundred parts of salt require for their complete decomposition ninety-five parts of acid, at 60° Baume=1.7 specific gravity, or one hundred and four parts of an acid, at 55° Baume=1.62 specific gravity.

This mixture of salt and acid is occasionally well stirred, and after the lapse of two or three hours it will have become sufficiently dry to rake over into an oven made of brick-work, attached to the furnace; this oven is kept at a bright heat, in order to expel the muriatic acid gas; it is then called sulphate of soda (NaO,SO_3+10HO). The sulphate of soda is then

reduced to powder, and then mixed with an equal weight of chalk, and half its weight of coal, which is well ground and sifted. This mixture is again put into a hot reverberatory furnace, and frequently stirred, until it is uniformly heated; in an hour it will fuse; it is then well stirred for a few minutes, and then drawn out into a cast-iron trough, where it cools and solidifies; this is called ball soda, and contains about thirty per cent of alkali. This ball soda is usually exposed to the action of the air for at least five days, so that it may become more porous, and hence be more readily acted upon by the water used to separate it from the insoluble matters, which is accomplished by breaking up the cake, and putting it into vats, and covering it with tepid water.

In about four hours the liquor is drawn off at the bottom, then more warm water is added and drawn off again, and so on for five or six times, which extracts all the soluble matters from the cake. These wash liquors are all put together, and boiled down to a dryness that forms a salt of carbonate of soda (NaO,CO_3), which contains a little caustic soda and sulphuret of sodium. To get rid of the sulphuret, they mix the salt with about one-third of its bulk of sawdust, then expose it to a low heat in another furnace for a few hours, which converts the caustic soda into a carbonate that carries off the sulphur. The product of this contains nearly fifty per cent. of alkali, and produces the best

Soda Ash.

A plan for the direct conversion of common salt into soda, and then again into soda-ash, has long been sought for, but never carried into practice successfully. It was found that if a concentrated solution of bicarbonate of ammonia is mixed with strong brine, or if we pulverize the bicarbonate of ammonia and stir it through a concentrated solution of common salt, and leave this mixture to stand, the result will be, after some hours, the bicarbonate of soda will

be deposited in a crystalline state, and the supernatant liquor will be a solution of sal-ammoniac (NH_3HCl).

The first operation consists in the action of ammonia and carbonic acid upon the concentrated salt solution (or brine). To one hundred parts of water, thirty-two parts of common salt, nine parts of ammonia, and carbonic acid in excess are added. The next step is the separation of the bicarbonate of soda, which is brought about by a centrifugal machine. The third stage is the calcination of the bicarbonate of soda, in cylindrical iron vessels, and the carbonic acid gas which is given is collected.

The fourth and fifth operations are for the recovery of the carbonic acid and ammonia from the liquid that drained from the bicarbonate of soda while it was in the centrifugal machine. These drainings are heated in a boiler. The effect will be the escape of the ammonia and carbonic gas, which is conducted to a cylinder filled with coke, through which a cold aqueous solution of carbonate of ammonia trickles, which causes the condensation of the ammonia, the carbonic acid escaping into a gas-holder.

The above plan has, however, not been successfully carried into practice.

Owing to the various circumstances and methods of manufacturing soda-ash, its percentage we find very uncertain; it will vary from forty to fifty per cent. It is generally priced according to the percentage of alkali that it contains. We might give a method for ascertaining the percentage, but as it requires a great deal of time and trouble, and it not being very essential to woolen-dyers, for the purposes for which they use it, it is of no consequence what per cent. of alkali it contains.

The methods for testing soda-ash might be of some benefit to dealers in it, but it is doubtful, to my mind, if they had the plan of testing it, whether they would ever take the trouble to perform the operation.

Soda-ash is soluble in twice its weight of cold water, and an equal weight of boiling water.

Its composition is—

Carbonic acid, ...	15.3
Soda, ...	22.0
Water, ...	62.7 = 100

In a dry atmosphere its water of crystallization evaporates, and the salt falls into a powder; one pound of this powder is equal in strength to two pounds of the crystals. If it is boiled with quicklime it will be deprived of its carbonic acid; then evaporate it to dryness, and it will be a pure soda; and its combining proportion with an acid is four.

A solution of soda-ash, brought to the boiling point, will attain 266° Fahr.

Carbonate of Soda (Na_2CO_3).

This salt is prepared by first dissolving soda-ash in water; the clear solution is then boiled until a pellicle appears upon the surface. The liquor is then run into shallow cast-iron troughs and allowed to cool, and as it cools it crystallizes. It is allowed to stand for five or six days; the mother-liquor is then drawn off, the crystals are drained, and then it is broken up and sent to the market. The mother-liquor is utilized by evaporating it to dryness, which makes a very impure soda-ash, containing not over thirty per cent. of alkali. This soda-ash is sold to soap-manufacturers.

Crystallized Carbonate of Soda (Na_2CO_3+10HO).

This salt is carbonate of soda, with about six per cent. of water, but it is a very pure salt. When these crystals are exposed to a dry atmosphere, they lose a portion of their water, and they will have a chalky-white appearance; and if exposed to heat, they will melt in their water of crystallization.

The composition of this soda is as follows, in one hundred parts by weight:

Water, ...	62.76
Carbonic acid, ...	15.43
Caustic soda, ...	21.81 = 100

We see by the above that more than three-fifths of their weight is water.

The carbonate of soda sold for domestic uses is crystallized soda, deprived of its water of crystallization.

Caustic Soda, or Sodium Hydroxide (NaO,HO).

This substance is met with in the market as a highly concentrated solution, or, more frequently, as a solid mass, being fused hydrate of soda, consisting, in one hundred parts, seventy-seven and one-half parts of soda and twenty-two and one-half parts of water. For a number of years a moderately strong solution of caustic soda was made by using caustic lime, with a solution of carbonate of soda. Dale was the first one to use this solution, instead of water, in his boilers, and by this plan concentrated the lye to a specific gravity of 1.24 to 1.25; after which he evaporated the lye to a specific gravity of 1.9. At this point it solidifies on cooling. At the present time caustic soda is not prepared with lime, but is prepared by simply increasing the quantity of small coal to the mixture of sulphate and chalk, the crude soda being at once lixiviated with water at 50° Fahr. After the liquor has cleared, it is rapidly concentrated to 1.5 specific gravity, at which point the carbonate, sulphate, and chloride of sodium are deposited; the liquor now assumes a brick-red color, due to the peculiar compound of double sulphuret of sodium and sulphuret of iron. The lye is next strongly heated in large cast-iron cauldrons; there is then added twenty-five pounds of Chili saltpetre for every hundred pounds of caustic soda required. By this operation the nitrate of soda reacts upon

the sulphuret of sodium and the cyanide of sodium present, which causes an evolution of ammonia and nitrogen. In England caustic soda of a very pure character is prepared from sodium, by carefully oxidizing the metal (sodium) with pure water in bright iron or silver vessels.

According to Dr. Dalton's researches, a caustic soda of the following specific gravities contains percentages of caustic-soda (NaHO) :—

Specific Gravity.	Caustic Soda (NaHO).	Specific Gravity.	Caustic Soda (NaHO).
2.00	77.8	1.40	29.0
1.85	63.6	1.36	26.0
1.72	53.0	1.32	23.0
1.63	46.6	1.29	19.0
1.56	41.2	1.23	16.0
1.50	36.8	1.18	13.0
1.47	34.0	1.12	9.0
1.44	31.0	1.06	4.7

Caustic soda is used for soap-making, paraffine, and petroleum refining, and for the preparation of silicate of soda; also for cotton-dyeing and calico-printing.

Sulphate of Soda ($NaOSO_3+10HO$) Crystallized.

Sulphate of soda, or Glauber's salt, consists, in one hundred parts, of 19.3 of soda, 24.7 of sulphuric acid, and 56 of water. The formula is, $NaOSO_3+10HO$. The formula for the anhydrous sulphate of soda is, Na_2SO_4, and consists, in one hundred parts: soda, 43.6; sulphuric acid, 56.4. It is prepared by decomposing common salt (NaCl) with sulphuric acid (H_2SO_4); if prepared thus it contains about one-third its weight of salt.

There are a number of methods used to prepare this substance.

First. The double decomposition of common salt and sulphate of magnesia from the mother-liquor of sea-water, or of

salines, when exposed to a low temperature, either natural in water or artificially by the assistance of Carre's ice-making machine.

Second. Langmaid's process of roasting sulphuret of iron or copper with common salt.

Third. Calcination of kieserite or magnesian sulphate with common salt.

Fourth. As a by-product of paraffine and petroleum refining.

The sulphate of soda of the alkali works contains, on an average, ninety to ninety-five per cent. of the pure salt, the remainder being chiefly salt.

Soda saturated with sulphuric acid makes the best sulphate of soda, and crystallizes very rapidly and easily. This salt is used more extensively in the woolen dye-house than formerly.

Sulphate of soda is a colorless salt, possessing a cooling, nauseous, bitter taste, and crystallizes easily and rapidly in six-sided prisms. When it has been made but a short time it is very transparent, but by exposure to the atmosphere it effloresces, and the crystals become covered with an opaque white powder; by long exposure it undergoes a complete efflorescence and falls into powder, with the loss of more than half its weight. Sulphate of soda is soluble in three times its weight of cold water, and in an equal weight of boiling water, but it is insoluble in alcohol. A supersaturated solution of it will remain without crystallizing at ordinary temperatures, although containing several times the weight of the salt that would be dissolved at the same degree of heat (*Gay Lussac*). But we find that the solution will instantly form into a crystalline mass if we add to it a small piece of the crystals of the same salt, or other substance that have been exposed to the air, or upon abruptly placing it in contact with the air. M. D. Gernez appears to have proved that in each instance the cause of crystallization is the same; namely, sulphate of soda containing ten equivalents of water, and, where the crystal itself is not added, the result is owing to sulphate of soda ex-

isting in the air. When sulphate of soda is subjected to heat it dissolves in its water of crystallization, then dries, and afterwards, by the application of a red heat, it melts and loses fifty-five and a half per cent. of its weight. Occasionally it contains an excess of acid or alkali, which may be detected by litmus or tumeric paper.

Sulphate of soda consists of one equivalent of sulphuric acid, one of soda, and ten of water; its prime equivalent is 161.3. Thus —

One equivalent of sulphuric acid is .	=40.0
One equivalent of soda is . .	=31.3
Ten equivalents of water is . .	=90.0=161.3

With respect to the solubility of soda,—

100 parts	of water	at 176° F.,	dissolve	78	parts	of caustic soda.
"	"	158°	"	72	"	"
"	"	131°	"	64	"	"
"	"	90° .	"	46	"	"
"	"	62°	"	41	"	"

The composition of crude soda, or ball soda is,—

Carbonate of soda (NA_2CO_3), . . .	45
Sulphuret of calcium ($2CaCl_2$), . .	30
Caustic lime, ...	10
Carbonate of lime ($CaCO_3$), . . .	5
Foreign substances, ...	10 = 100

Composition of soda containing caustic soda:

Moisture, ...	2.10
Insoluble matter, ...	0.12
Chloride of sodium (NaCl), . .	4.32
Sulphate of soda (Na_2SO_4), . .	8.80
Carbonate of soda (Na_2Co_3) . .	82.47
Caustic soda (NaHO) . . .	2.11 = 100.00

Composition of refined soda:

Moisture, ...	1.00
Insoluble matters, ...	–
Chloride of sodium ($NaCl$), . .	2.11
Sulphate of soda (Na_2SO_4), . .	1.50
Carbonate of soda (Na_2CO_3), . .	95.39 = 100.00

One hundred parts of water at 175° Fahr., will dissolve seventy-five parts of soda.

Stannate of Soda.

This salt is now used to a large extent in cotton-dyeing and calico-printing, but not often used in wool-dyeing except in some cases as a mordant or preparation for some of the aniline dyes, when they are required to resist the fulling or scouring process.

Stannate of soda is prepared in various ways — sometimes by fusing tin-ores with caustic soda, and then lixiviating this melted mass with water, or by boiling soda-lye with litharge and metallic tin, the result being the formation of stannate of soda and metallic lead.

Dr. Hoffely modifies the above process by digesting litharge with soda-lye, at about twenty-two per cent., in a metallic vessel; he thus obtains a solution of plumbate of soda, into which he puts granulated or feathered tin, and applies heat.

There has been presented a salt for calico-printing, under the name of *stanno-arsenite of soda*. It consists of a combination of arsenic, soda, and protoxide of tin.

Sometimes a stannite of soda is prepared by dissolving crystals of tin in water containing an excess of caustic soda, but this is a very unstable preparation, and is neither fit for dyeing or calico-printing.

Part Third.

ALPHABETICAL TABLE OF ELEMENTS, THEIR SYMBOLS, ETC.;

COAL-TAR COLORS;

HISTORY OF COAL-TAR COLORS; RESULT OF IMPROVEMENTS, ETC.

TABLE OF ELEMENTS, ETC.

HYDROMETERS.

Baume's and Twaddle's hydrometers are universally used in print-works, but Twaddle's is the standard in dye-houses, which is an arbitrary scale. Baume's hydrometer is commonly used by apothecaries; it is made like other hydrometers as regards the form. The one used for alcohol is graduated by loading it, until it sinks to the bottom of the stem or straight part (which is marked 0, zero), in a solution composed of one part of common salt and nine parts of water; it is then put into water, and the place to which it sinks is marked 10° of the scale, and from this the rest of the scale is marked. For hydrometers to use for liquids which are heavier than water, it is loaded until it will sink in distilled water to the top of the stem; it is then put into a solution made of fifteen parts of salt and eighty-five parts of water, and the place to which it sinks in this solution is marked 15°, and the scale is divided off from that each way.

There are hydrometers made especially for acids, saline solutions, and for syrups. The hydrometers which are imported are so carelessly made that it is very difficult to find two that will agree, and little dependence is to be placed on their accuracy. The hydrometers used by physicians and apothecaries are manufactured by W. H. Pile, Philadelphia, and can be relied upon for their accuracy.

The following table will show the corresponding degrees of Baume's and Twaddle's hydrometers sufficiently accurate for all practical purposes. The degrees on Baume's scale are very empirical, but Twaddle's hydrometers, we find, are based upon the liquid's specific gravity.

In order to find the specific gravity of a fluid by Twaddle's hydrometer, we multiply the degrees given on the scale by five and add one thousand, then point off three figures as decimals; thus, suppose nitric acid to indicate 64°, which is the average strength, we multiply by five times 64 = 320; now add the 1,000 = 1,320, being the specific gravity of nitric acid at 64° strength; and to find the degree of Twaddle corresponding to any specific gravity, we divide the *decimal part* of the specific gravity; thus the decimal part of the above specific gravity is three hundred and twenty, and five in three hundred and twenty goes sixty-four times, the degrees of Twaddle's hydrometer.

Degrees Twaddle.	Degrees Baume.	Specific Gravity	Degrees Twaddle.	Degrees Baume.	Specific Gravity.
1, . . .	1	1.007	50, . .	29	1.252
3, . . .	2	1.014	52, . .	30	1.256
4, . . .	3	1.022	55, . .	31	1.260
6, . . .	4	1.029	57, . .	32	1.264
7, . . .	5	1.036	59, . .	33	1.268
9, . . .	6	1.044	62, . .	34	1.309
10, . . .	7	1.052	64, . .	35	1.321
12, . . .	8	1.060	67, . .	36	1.334
13, . . .	9	1.067	69, . .	37	1.346
15, . . .	10	1.075	72, . .	38	1.359
17, . . .	11	1.083	74, . .	39	1.372
18, . . .	12	1.091	77, . .	40	1.384
20, . . .	13	1.100	80, . .	41	1.398
22, . . .	14	1.108	82, . .	42	1.412
23, . . .	15	1.116	85, . .	43	1.426
25, . . .	16	1.125	88, . .	44	1.440
27, . . .	17	1.134	91, . .	45	1.454
29, . . .	18	1.143	94, . .	46	1.470
30, . . .	19	1.152	97, . .	47	1.485
32, . . .	20	1.161	100, . .	48	1.501
34, . . .	21	1.171	103, . .	49	1.515
36, . . .	22	1.180	106, . .	50	1.532
38, . . .	23	1.190	110, . .	51	1.549
40, . . .	24	1.199	113, . .	52	1.566
42, . . .	25	1.210	117, . .	53	1.583
44, . . .	26	1.221	120, . .	54	1.601
46, . . .	27	1.231	124, . .	55	1.618
48, . . .	28	1.242	127, . .	56	1.637

Degrees Twaddle.	Degrees Baume.	Specific Gravity.	Degrees Twaddle.	Degrees Baume.	Specific Gravity.
131, . .	57	1.656	152, . .	62	1.758
135, . .	58	1.676	156, . .	63	1.779
139, . .	59	1.695	160, . .	64	1.801
143, . .	60	1.714	164, . .	65	1.820
147, . .	61	1.736	168, . .	66	1.840

THERMOMETERS.

Thermometers are plentiful and cheap, but we will not give a detailed account of their manufacture. Suffice it to say, that a good thermometer is an essential instrument in the dye-house, as very often in cotton-dyeing, and frequently in woolen-dyeing, it is required to have the solutions a certain heat. The thermometers used in this country are generally those of Fahrenheit; in Europe the Centigrade, and sometimes Reaumur's thermometer, are used to a great extent. Thermometers are generally indicated by abbreviations, as: F. or Fahr., for Fahrenheit's scale; R. or Reau., for Reaumur's; and C. or Cent., for Centigrade. Fahrenheit divided the two points, from the boiling of water to its freezing, into 180°; he called the freezing-point the thirty-second degree, for some particular reason of his own; he, however, gave no reason for this to the world at large; so by the taking 32°, the point where water freezes, and adding the 180° intervening between that and his boiling-point, we have the 212°, which is marked upon his scale as the boiling-point of water. Reaumur has divided his into 80° between the two points, from freezing to the boiling of water. The centigrade is divided into 100° between the two points, from the freezing to the boiling point, the freezing-point being marked 0, the boiling-point 100°. In studying or reading works upon dyeing, where temperature is referred to in the processes or recipes, attention should be paid to what scale of thermometer

is referred to. The degrees of one can be converted into the other, by a very simple rule. For instance, we wish to convert the centigrade scale to the Fahrenheit. Suppose a liquid indicates 80° centigrade, we multiply 80 by 9=720, this divided by 5=124; now we add 32, making it 156 degrees Fahrenheit. To convert Reaumur to Fahrenheit, multiply the degree given by 9, divide by 4, and add 32, as in the above example.

Any degree of the *centigrade* scale, multiplied by 4, and divided by 5, will give the corresponding degree of *Reaumur*, and conversely; and the degree of *Reaumur*, multiplied by 5, and divided by 4, will give the corresponding degree of *centigrade*.

The following table will show the corresponding degree of Fahrenheit to degrees on the centigrade scale, so that the comparative value of the two scales, will be easy for the dyer to ascertain and guide him in the use of either one of them:—

Cent	Fahr.	Cent.	Fahr.	Cent.	Fahr.
0, . .	32	21, . .	69.8	42, . .	107.6
1, . .	33.8	22, . .	71.6	43, . .	109.4
2, . .	35.6	23, . .	73.4	44, . .	111.2
3, . .	37.4	24, . .	75.2	45, . .	113
4, . .	39.2	25, . .	77	46, . .	114.8
5, . .	41	26, . .	78.8	47, . .	116.6
6, . .	42.8	27, . .	80.6	48, . .	118.4
7, . .	44.6	28, . .	82.4	49, . .	120.2
8, . .	46.4	29, . .	84.2	50, . .	122
9, . .	48.2	30, . .	86	51, . .	123.8
10, . .	50	31, . .	87.8	52, . .	125.6
11, . .	51.8	32, . .	89.6	53, . .	127.4
12, . .	53.6	33, . .	91.4	54, . .	129.2
13, . .	55.4	34, . .	93.2	55, . .	131
14, . .	57.2	35, . .	95	56, . .	132.8
15, . .	59	36, . .	96.8	57, . .	134.6
16, . .	60.8	37, . .	98.6	58, . .	136.4
17, . .	62.6	38, . .	100.4	59, . .	138.2
18, . .	64.4	39, . .	102.2	60, . .	140
19, . .	66.2	40, . .	104	61, . .	141.8
20, . .	68	41, . .	105.8	62, . .	143.6

Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.
63, . .	145.4	76, . .	168.8	89, . .	192.2
64, . .	147.2	77, . .	170.6	90, . .	194
65, . .	149	78, . .	172.4	91, . .	195.8
66, . .	150.8	79, . .	174.2	92, . .	197.6
67, . .	152.6	80, . .	176	93, . .	199.4
68, . .	154.4	81, . .	177.8	94, . .	201.2
69, . .	156.2	82, . .	179.6	95, . .	203
70, . .	158	83, . .	181.4	96, . .	204.8
71, . .	159.8	84, . .	183.2	97, . .	206.6
72, . .	161.6	85, . .	185	98, . .	208.4
73, . .	163.4	86, . .	186.8	99, . .	210.2
74, . .	165.2	87, . .	188.6	100, . .	212
75, . .	167	88, . .	190.4		

ALPHABETICAL TABLE OF ELEMENTS — THEIR SYMBOLS AND PRIME EQUIVALENTS.

This table includes all of the elements, although many of them are not used in the art of dyeing; excluding aridium and donarium, which have not yet maintained their claim as being distinct metals.

By modern chemists the elements are designated by letters, which are called *symbols*. The initial letter of the name is the symbol, whenever it is distinctive; but when several elements have names beginning with the same letter, the plan adopted is to represent one of them by the initial letter, and the rest by the initial letter with some other associated with it. Thus C stands for carbon, Cu for copper, Cl for chlorine, Ca for calcium, Cr for chromium, Cd for cadmium, Co for cobalt, &c. The use of these symbols saves time and space in designating the composition of compounds. Where a single equivalent is intended to be given, the symbol of the element is only given; but when two or more equivalents are to be represented, the symbol has the number of the equivalents placed before the symbol. Thus O means one equivalent of oxygen, 3O means three equivalents of oxygen, and

so on. The number of equivalents is now generally denoted by a depressed figure following the symbol; thus, N_2O means two equivalents of nitrogen and one of oxygen. Sometimes there are two or more proportions of a compound combined with another compound; in that case, it is represented by placing the figure before the compound to be multiplied, and a comma or a + at the end. Thus, $3SO_3$,Fe. The figure 3 applies to all between it and the comma, meaning three equivalents of sulphuric acid and one equivalent of iron. The sign + is now generally used, instead of the comma. Thus, $3SO_3$+Fe. The symbols given are those of Berzelius, and should not be varied from, for fear of destroying their usefulness, by creating confusion.

As it is of great importance that these symbols should be understood by the young dyer, as well as by the older ones, we will give a few of the combinations, with their explanations, thus:

NO_5 = concentrated nitric acid.

HO,NO_5 = monohydrated nitric acid (nitrate of water), or the commercial or common nitric acid.

SO_3 = sulphuric acid.

HO,SO_3 = monohydrate (sulphate of water, the common oil of vitriol).

HO,$2SO_3$ = Nordhausen, or the concentrated oil of vitriol.
Or thus:

SO_3 = one equivalent of sulphur, and three equivalents of oxygen, is sulphuric acid.

HO,NO_5 = one equivalent of water, one of nitrogen, and five of oxygen, is common nitric acid.

HO,$2SO_3$ = one equivalent of water, and two of sulphuric acid, is concentrated oil of vitriol.

SO_3FeO + 5HO = sulphuric acid, oxide of iron, and water, — copperas.

Some chemists write it thus: FeO,SO_3 + 5HO; but according to Berzelius, it is FeO,SO_3 + 7HO.

"To make up the equivalent weight of any compound from symbols, we have simply to multiply the elements given according to the table. Thus, suppose we take the sulphuric acid, and two parts of water ($SO_3 2HO$), which is strong vitriol, we have —

	Equivalent weight.
One of sulphur, ...	$= 16$
Three of oxygen, ...	$8 \times 3 = 24$
Two of water, 1 of hydrogen, and 8 of oxygen,	$9 \times 2 = 18$
	58

which is the proportion or weight of sulphuric acid of the strength which would be required to combine with any other element, suppose iron, which is twenty-eight; therefore, it would require fully twice the weight of sulphuric acid of this strength to that of a piece of iron, to dissolve it."

The formula of common alum will serve us as an illustration of the symbols and equivalunts —

$$Al_2O_3,3SO_3 + KO,SO_3 + 24HO.$$

This is in accordance with Berzelius, but it has become general to write alum thus:

$SO_3,Al_2 =$ sulphate of alumina, or alūmina sulphate $= Al_2SO_3$.

Table of Elements.

Name of Element.	Symbol.	Prime Equivalent.	Name of Element.	Symbol.	Prime Equivalent.
Aluminum, .	Al	13.7	Beryllium, .	Be	4.7
Antimony (stibium), . .	Sb	122.	Cadmium,. .	Cd	55.8
Arsenic, . .	As	75.	Calcium, . .	Ca	20.
Barium, . .	Ba	68.7	Carbon, . .	C	6.
Bismuth, . .	Bi	210.	Cerium, . .	Ce	46.
Bromine, . .	Br	78.4	Chlorine, . .	Cl	35.7
Boron, . .	B	10.9	Chromium, .	Cr	26.3
			Cobalt, . .	Co	29.5

TABLE OF ELEMENTS.—Continued.

Name of Element.	Symbol.	Prime Equivalent.	Name of Element.	Symbol.	Prime Equivalent.
Copper, . .	Cu	31.7	Pelopium, . .	Pe	?
Columbium (Tantalum*), .	Ta	185.	Phosphorus, .	P	32.
Didymium, .	Di	47.5	Platinum, . .	Pt	98.9
Erbium, . .	E	56.3	Potassium (Kalium), . .	K	39.2
Flourine, . .	Fl	18.7	Rhodium, . .	R	52.2
Glucinium, .	G	7.	Ruthenium, .	Ru	52.2
Gold (aurum), .	Au	199.	Rubidium, . .	Rb	85.4
Hydrogen, . .	H	1.	Selenium, . .	Se	40.
Ilmenium, . .	Il	60.2	Silicon (silicium),	Si	21.3
Indium, . .	In	74.	Silver (argentum), . .	Ag	108.
Iodine, . .	I	126.3	Sodium (natrium), . .	Na	23.3
Iridium, . .	Ir	98.8	Strontium, .	Sr	43.8
Iron (ferrum), .	Fe	28.	Sulphur, . .	S	16.
Lanthanium, .	La	44.3	Tantalum (Calumbium), .	Ta	185.
Ledd (plumbum), . .	Pb	103.6	Tellurium, .	Te	64.
Lithium, . .	L	7.	Terbium, . .	Tb	?
Magnesium, .	Mg	12.	Thallium, . .	Tl	204.
Manganese, .	Mn	27.7	Thorium, . .	Th	59.6
Mercury (hydrargyum), . .	Hg	200.	Tin (stannum),	Sn	59.
Molybdenum, .	Mo	48.	Titanium, . .	Ti	25.
Nickel, . .	Ni	29.5	Tungsten (Wolframium), .	W	92.
Niobium,† . .	Nb	94.	Uranium, . .	U	60.
Nitrogen (azote), . .	N	14.	Vanadium, .	V	51.2
Norium, . .	No	?	Yttrium, . .	Y	38.85
Osmium, . .	Os	99.7	Zinc, . . .	Zn	30.85
Oxygen, . .	O	8.	Zirconium, .	Zr	33.6
Palladium, . .	Pd	53.3			

* According to H. M. Rose, the columbium of Hatchett, and the tantalum of Ekeberg, are distinct metals.

† Niobum and pelopium were alleged to exist in the Bavarian and North American columbites. But H. M. Rose has announced that they are the same, and proposes to retain the name niobium. It is not contended that the peculiar metal of the columbites is different from that discovered in 1801 by Hatchett; therefore, as justly remarked by Prof. A. Connell of St. Andrews, it should be called *columbium*, the name given it by its discoverer, and the name *niobium* should be abandoned.

These are all the elements known to chemists at the present time, and all the varieties in which we find matter presenting itself to us, whether in the animal, the vegetable, or the mineral kingdom, are made up of one, or an admixture of two or more of these elements.

We find that when two or more of these elements combine, the union always takes place in definite proportions, and that these proportions are expressed by figures placed opposite to the names in the table. "For example, if we should mix together one ounce of hydrogen, and one ounce of oxygen, and bring them under circumstances to cause combination, it is found that the one ounce of oxygen has combined with an eighth part of the hydrogen, and that other seven ounces of oxygen are required to combine with the whole of the hydrogen. Their combining properties are therefore set down as one to eight. This holds good for all of the elements, so that the union is always definite and distinct."

"One element, however, is often found to combine with another in a greater number of proportions than one to one. Thus, suppose nitrogen — which, according to the table of elements, has a combining weight of fourteen — combines with oxygen in proportions as follows:

One nitrogen=14 to one oxygen=8.
One nitrogen=14 to two oxygen=16, two times 8.
One nitrogen=14 to three oxygen=24, three times 8.
One nitrogen=14 to four oxygen=32, four times 8.
One nitrogen=14 to five oxygen=40, five times 8."

"Thus, we observe, that the proportion of oxygen is always eight, or a multiple of eight; so it is with nitrogen, always fourteen, or twice fourteen, and so on to any number of multiples of fourteen. The same rule holds good with every element in the table; they combine only according to the number following the name."

"But when they thus combine in different and distinct quan-

tities, the compounds formed are also distinct and definite. Thus, one proportion of nitrogen and one of oxygen is laughing-gas; and it is so at all times and under all circumstances, and can be nothing else. But when two of oxygen combine to one of nitrogen, a different substance is formed from laughing-gas, also distinct and definite from every other proportion in which the elements unite. The first and last of the above list is an apt illustration — the former being laughing-gas, the latter *aqua fortis*, or nitric acid."

"The letters placed immediately after the names of the elements are the symbols commonly used to represent the respective elements, and to facilitate the expression of the compounds into which they enter. Thus, to represent laughing-gas, we write NO, which means one of nitrogen and one of oxygen. The symbol always represents the weight of the *proportion*, as given in the table, and the figures which are attached show how often that proportion is repeated."

The formula for sulphuric acid is SO_3, which means one of sulphur and three of oxygen, the figure being placed after the symbol which is multiplied. To find the equivalent of any formula, we will take nitric acid as an example: NO_5, which means one of nitrogen=fourteen, and five of oxygen=forty; oxygen being eight, and there being five proportions of it, we say five times eight are forty, to which we add the one proportion of nitrogen, that being fourteen; so fourteen and forty make fifty-four, that being the prime equivalent of nitric acid.

It will be seen, by looking over the table of elements, that there are a number of substances there named which a great many of us have never heard of; that is, that have never been defined. There are in the table a number of elements of which little is known, except the fact of their existence in certain compounds, they having been seen only by the discoverers and a few friends, and are as yet so rare, and found in such small quantities, that, at the present time, their applica-

tion to any of the common branches of manufactures is not thought of.

COAL-TAR COLORS.

Coal-tar is a substance obtained as a by-product of the dry distillation of coal for the purpose of manufacturing illuminating gas, and is a complex mixture of a large number of substances, such as fluid and solid hydrocarbon, called benzole, toluol, cumol, cymol, anthracene, and naphthaline. The acids contained in coal-tar are, the carbolic or phenylic, cresylic, phlorylic, and rosolic. The bases are aniline, chinoline, odorin, picoline, toluidine, coridine, &c. If we leave the small amount of basic substances that the tar contains, we find that it consists of the following substances in one hundred parts of the coal-tar:

Benzole,	1.5
Naphtha,	35.0
Napthaline,	22.0
Anthracine,	1.0
Carbolic acid,	9.0
Pitch,	31.5=100.

By the distillation of coal-tar, there is obtained two kinds of oil—the light, and the heavy or dead oil; one is lighter, and the other heavier, than water. The light oil is separated into crude naphtha, which contains the benzole or benzine, toluol, &c. The heavy oil is used for making carbolic acid. This heavy or dead oil, is rich with naphthaline. This crude naphthaline can be purified by pressing out the fluid hydrocarbons, which contaminate it, and then subliming it with the addition of sand and lime, which will retain the impurities. The purified naphthaline is in the form of white and pearl-

colored scales, and has to be submitted to a number of operations to transform it into several dyes.

The acid substances contained in the coal-tar are removed by the caustic solutions of soda and potash, the basic substances by weak sulphuric or muriatic acid; the benzole, toluol, naphthaline, &c., are separated by fractional distillation.

The most useful of the substances contained in coal-tar for the manufacturing of coal-tar colors, or aniline, are the benzole, toluol, naphthaline, and carbolic acid; the other substances are found mixed with the above, but their action is little known, comparatively speaking. Benzole, chemically speaking, is a fluid hydrocarbon, and was discovered by Faraday (in 1825) among the products of the dry distillation of oil, in the liquid resulting from the strongly compressed oil-gas.

Mitscherlich, in 1833, obtained it by the distillation of benzoate of lime. Leigh, at Manchester, Eng., in 1842, first discovered benzole in coal-tar; and to Mansfield are we indebted for the method of separating benzole from tar by a process which is available on a large scale.

Benzole is sold to the aniline manufacturers at a certain specified percentage of benzole (C_6H_6); for instance, benzole at thirty or forty per cent. contains, by bulk or weight, as may be agreed upon, the above percentage of benzole, the rest being sixty or seventy per cent. toluol and oxylol, forming a fluid which is suitable for manufacturing aniline red; but for making aniline blue or black, it requires a fluid containing nearly ninety per cent. of benzole. The boiling-point of benzole used for making the different aniline-dyes varies from 90° to 125° Fahr., and the specific gravity varies from 85 to 89. H. Caro, A. and K. Clemm, and F. Englehorn have suggested that, instead of manufacturing benzole from coal-tar, it should be extracted from coal-gas by causing this to be passed slowly through tar-oils, which have a higher boiling-point than benzole or toluol, &c., and to extract, by distillation, the benzole,

&c., from these heavy oils after they have become saturated. The heavy oils can serve the same purpose again. And as regards the depreciation of the illuminating power of the gas, caused by the extraction of the hydrocarbons, benzole, &c., which were present in the gas as vapors, these gentlemen suggest the saturation of the gas with benzaline (petroleum oil).

The first operation in the manufacture of aniline-dyes is the transforming of the mixture of benzole and toluol into nitro-benzole and nitro-toluol, by the action of nitric and sulphuric acids; the mixture of the acids being two parts of nitric acid at 40° Baume, — specific gravity, 1.384; and one part of concentrated sulphuric acid, — specific gravity, 1.848; the operation being carried on in closed vessels similar to those used for making aniline. The upper part of the apparatus is fitted with a tube, for the purpose of conveying the nitrous-acid fumes to a chimney, and there is an S-shaped tube connecting the apparatus to the tank that contains the acid mixture. The amount of benzole which is intended to be nitrated is put into the apparatus at one time; the mixed acids are poured gradually into the benzole, and the re-action aided by a stirring-machine. Any benzole which is volatilized by the heat caused by the re-action, is condensed by an apparatus connected to the re-action vessel, and is thus saved. When the re-action has ceased, it is known by the liquid becoming colorless and its being separated into two distinct strata by the addition of water. The nitro-benzole and nitro-toluol thus produced are separated from the acid by washing in water, to which has been added carbonate of soda; this forms the commercial nitro-benzole or nitro-benzine.

On E. Kopp's suggestion, nitro-benzole is now manufactured by the aid of a mixture of nitrate of soda and sulphuric acid.

"One hundred kilos of benzole yield one hundred and thirty-five to one hundred and forty kilos of nitro-benzole."

There are three different kinds of nitro-benzole, viz.: —

"The light nitro-benzole, boiling at 210°. This kind is used in perfumery and soap-making in very large quantities, and is called *essence de mirbane* and oil of bitter almonds, and has a specific gravity of 1.20 (=24° B.)"

"Second. Heavy nitro-benzole, boiling between 210° and 220°, possessing a peculiar fatty smell. It is not used in perfumery, but chiefly for the preparation of aniline-red; specific gravity, 1.19 (=28° B.)"

"Third. Very heavy nitro-benzole, boiling between 222° and 235°; specific gravity, 1.167 (=58° B.); this kind has a disagreeable odor, and is chiefly used for the preparation of aniline, intended for making aniline-blue."

After converting the coal-tar into nitro-benzole and nitro-toluol, the next operation consists in deoxidizing these substances by replacing their oxygen, with a certain amount of hydrogen. This reduction is effected by various processes,—by sulphide of ammonium and by nascent hydrogen. Although sulphuretted hydrogen will completely reduce nitro-benzole to aniline, those manufacturing aniline upon a large scale prefer to use Bechamp's method, it being found the most advantageous in practice; that method being the mixture of one part of nitro-benzole with one part of acetic acid, to which is added one and one-half parts of iron-turnings. The apparatus used for this operation was devised by Nicholson, being a cast-iron cylinder furnished with a stirring apparatus and a condenser. After the iron, acid and nitro-benzole are placed in the cylinder, heat is applied and the whole is distilled, except the peroxide of iron, which remains in the cylinder or retort. The substance that boils over through a tube into a vessel for that purpose is the crude aniline. This is mixed with lime or soda and re-distilled, care being taken to collect only that which comes over at 180°; but there is a product that comes over at between 210° and 220°, that is very suitable for making aniline-blue. The aniline-oil thus obtained is a brown-colored liquid, heavier than water, and pure enough for mak-

ing the aniline-colors. The pure aniline has a specific gravity of 1.020, and boils at 360° Fahr.; it emits vapors at the common temperature of the atmosphere, and when burning gives off a large, smoky flame. It is slightly soluble in water, its solvents being ether and alcohol; it will form salts with acids. According to the researches of Brimmeyer, the acetic acid is not necessary, and a very good result may be obtained by mixing sixty parts of iron with two to two and a half per cent. of muriatic acid, and then pouring it upon the nitro-benzole, leaving it in the retort for three or four days before distilling off the aniline-oil. In the aniline works of Paris nitro-benzole is reduced to aniline by the aid of iron-filings, which have been coated with copper by being immersed a solution of sulphate of copper.

The composition of aniline oil, essentially a mixture of aniline and toluidine, depends upon the benzole and nitro-benzole used in making the oil. The aniline oil that boils between 180° and 190° (and has a specific gravity of 1.014 or 1.021, and 2° to 3° B.) is prepared from nitro-benzole, which boils between 210° and 220°, and the aniline it yields is chiefly used for making aniline-red or fuchsine, while for making aniline-blue a very heavy nitro-benzole is used, and for aniline-violet, a nitro-benzole which boils at 210° or 225°. The table below shows the boiling-point of the substances which have been mentioned:

"Benzole,	80°,	Nitro-toluol,	225°
Toluol,	108°,	Aniline,	182°
Nitro-benzole,	213°,	Toluidine,	198°"

The aniline oil is used for making what is called the aniline colors, such as aniline-red, aniline-blue, aniline-violet, aniline-green, aniline-yellow, aniline-orange, aniline-brown, aniline-black, &c.

The aniline-red, known as fuchsine, azaleine, mauve, solferino, roseine, tyraline, &c., is the combination of a base

which Dr. A. W. Hoffmann has named rosaniline, with an acid, which is usually either muriatic or acetic acid.

The base rosaniline is a colorless substance, but its readily crystallizing salts are colored. The composition of this base may be expressed by the formula, $C_{20}H_{19}N_3H_2O$, and is formed by the combination of two atoms of toluidine with one atom of aniline. One hundred parts of aniline oil will yield twenty-five to thirty-three parts of crystalline fuchsine.

Although there is great danger in using arsenic acid, and great difficulty in disposing of the poisonous residues left by this method of preparing fuchsine, yet a large majority of fuchsine manufacturers use the arsenic method in preference to the other methods of obtaining it from the oil.

According to Girard and De Laire's method, one hundred weight of aniline oil and two hundred of hydrate of arsenic acid, at 60° B. (=specific gravity 1.71), are heated after being mixed, for five or six hours, at a temperature which should not be above 190° or 200°. The red fumed mass which is formed by this operation is broken up into small lumps, and then boiled with water. When the mass is all dissolved, it is filtered through felt bags, and then poured into tanks, for the purpose of obtaining the crystals. After remaining in these tanks three or four days, the mother-liquor (a very poisonous liquid) which covers the crystals, is run off into water-tight tanks made of stone and coated with asphalt, and to precipitate from this mother-liquor the arsenic and arsenious acids, there is a mixture of chalk and lime added; the precipitate formed is employed for making the various arsenical preparations. (The fuchsine made as above is known as rubine.) The crystalline mass is purified by the operation of re-crystallization.

In France the fused mass is dissolved in muriatic acid and water, and then neutralized with soda. The fuchsine by this process is obtained in a crystalline cake, and is again dissolved by being boiled in water, and the solution is allowed to

crystallize. Fuchsine obtained by this method always contains arsenic.

The salts of rosaniline, such as hydrochlorate of rosaniline, acetate of rosaniline, and the nitrate of rosaniline, by reflected light, have a green golden color, and by a remitted light, a red color. These salts, when dissolved in alcohol or water, exhibit a very beautiful carmine-red color, and their coloring powers are exceedingly high. Fuchsine is the basis of a greater part of the other aniline colors.

The researches of Dr. Hoffmann, Girard, and De Laire, have given us much light upon the composition of aniline colors; yet there is not at the present day a correct theory of these colors; that is, a theory that will answer all cases, or explain satisfactorily all of the transformations. These are the opinions now held by some of our most eminent chemists: *first*, that aniline or toluidine alone does not produce colors, while their admixture will; *second*, aniline or toluidine will both of them give colors; *third*, toluidine alone is the true source of the colors, but it requires the aid of aniline oil to produce them.

Aniline Violet.

This is known as aniline purple, violine, mauveine, and was discovered by Dr. W. H. Perkins, in 1856, and is manufactured by the action of bichromate of potash and sulphuric acid. It is also prepared by other re-actions, such as a salt of aniline with hydrochlorite of lime, with peroxide of manganese, and with peroxide of lead. These two last-named substances are used along with sulphuric acid, by treating aniline oil with chlorine; also, with chloride of copper; but Dr. Perkins's method with bichromate and sulphuric acid, is now generally used.

The base of the violet obtained by his method is called mauveine; formula ($C_{27}H_{24}N$).

The *violet imperial*, which was obtained by Girard and De Laire, by the action of chromate of potash upon a mixture of hydro-chlorate of rosaniline and aniline oil, heated to 180°,

differs essentially from the product mauveine, named above, and another violet is obtained, according to Nicholson's process of heating fuchsine to 200° or 215°, at which temperature the fuchsine melts, evolves ammonia, and the violet is produced. When a salt of rosaniline is heated with an excess of aniline oil, there are formed violet pigments, such as red violet, blue violet. Hoffmann classifies them thus:—

"The red violet is monophenyl-rosaniline.
The blue violet is diphenyl-rosaniline."

The latter substance yields, on being further heated, triphenyl-rosaniline or aniline blue. The formulas of these substances, according to Hoffmann, are—

"Rosaniline red ($C_{20}H_{21}N_3O$).
Monophrenyl-rosaniline (red violet—$C_{20}H_{20},C_6H_5,N_3O$).
Diphenyl-rosaniline (blue violet—$C_{20}H_{19},C_6H_{5,2}N_3O$).
Triphenyl-rosaniline (blue—$C_{20}H_{18},C_6H_{5,3}N_3O$)."

The *violet de Paris*, which was introduced by Poirrier and Chappat, is produced by the action of chloride of tin (muriate of tin), and similar compounds upon the ethyl or methyl aniline.

Blues can be produced from these violets by washing them in muriatic acid a number of times, which dissolves what aniline oil and fuchsine remain undecomposed. Aniline violets generally contain some red, and the blues some violet shades in them.

Aniline Blue.

This color, which is also known by the name of azuline and azurine, was first discovered by De Laire and Girard, in 1861, by heating a mixture of fuchsine and aniline oil together for a few hours, and then treating the product of this re-action with muriatic acid, and the result is the blue dye known as *bleu de Paris*, or *bleu de Lyons*, and is a copper-colored, shining sub-

stance, and does not give a green or yellow appearance when viewed by a reflected light, as the fuchsine and aniline violet do. In order to purify the aniline blue, it is first dissolved in concentrated sulphuric acid, and the mixture heated to 150° for two hours; water is then added to the solution, which causes the blue to precipitate in a modified and soluble form, which is then called soluble blue, or *bleu soluble.* The conversion of fuchsine, by heating with aniline oil, into the aniline blue (as stated above), is elucidated by the following formula, according to Dr. Hoffmann—

$$\text{“}\underset{\text{Rosaniline salt.}}{C_{20}H_{19}N_3ClH} + \underset{\text{Aniline.}}{3C_6H_7N} = \underset{\text{Aniline blue.}}{C_{20}H_{16},C_6H_{5},{}_3N_3HCl} + \underset{\text{Ammonia.”}}{3NH_3}.$$

"The aniline blue thus prepared is rosaniline ($C_6H_42C_7H_6H_3 + N_3$), in which three atoms of basic hydrogen have been substituted for three atoms of phenyl (C_6H_5); or, in other words, this aniline blue is triphenyl-rosaniline, the hydrochlorate of which is $C_{38}H_{32}N_3Cl$."

Aniline Green.

We are acquainted with but two kinds of this color, the aldehyde green, and the iodine. The first, also called emeraldine, was discovered by Cherpin, chemist at the aniline works in Saint Ouen, in 1863, and is made by treating a sulphuric-acid solution of the sulphate of rosaniline with aldehyde. By heating this mixture with great care, there will be a deep green pigment obtained, which contains sulphur. When it is used for coloring, hyposulphite of soda is added to it, then boiled until all is dissolved, before immersing the wool or fabric. This is used more for silk-dyeing than for wool or cotton. Sulphuret of ammonium, or sulphuretted hydrogen, can be used in place of the hydrosulphite of soda. This aniline green is very beautiful when viewed by artificial light.

The iodine green is manufactured by the following process: One part of acetate of rosaniline, two parts of iodine of methyl, and two parts of methylic alcohol are mixed together,

and heat applied for several hours, under a high pressure. When the operation is completed, the result is a mixture of green and violet substances, dissolved in the alcohol. The volatile substances having been driven off by the operation of distilling, the mixture of pigments is next put into boiling water, in which the green is completely dissolved, but the violet pigment will remain insoluble. The green is now precipitated by a saturated solution of picric acid in cold water. This precipitate (called picrate of iodine green) is collected upon a filter, and then quickly washed with water, and, when partly dried, is brought into the market as a paste.

A crystalline iodine, which is free from picric acid, has this formula—$C_{25}H_{33}N_3OI_2$.

To print cotton goods with this aniline, the first process is to prepare or mordant the cloth with chlorate of potash, then mix nine pounds of starch and one and a half pounds chlorate of potash together, and when perfectly cold add four and a half pounds of the aniline. After the goods are printed, they are placed in the ageing-room, where after a few hours, a bright green will appear; the cloth is then washed off. Should the printed goods be run through a solution of bichromate of potash, the green color would be transformed into a dark indigo blue, caused by a further oxidation of the green color. Soap or alkalies will turn this green into a blue, but by immersing the goods in an acidulated bath, the green color is restored to its primitive shade again.

Aniline Yellow.

This color is known also as phospine, victoria orange, and chrysaniline yellow. The last named is the secondary product, from the manufacture of aniline red or fuchsine, and is used for dyeing, combined with acetic and muriatic acid. Chrysaniline colors wool and silk a most brilliant yellow. Chrysaniline was extracted by Nicholson, from a resinous substance found in aniline oil, as a brilliant yellow-colored pigment, and he called it one of the bases of rosaniline.

Schiff obtained aniline yellow, by the action of hydrated oxide of tin upon aniline. M. Vogel obtained a yellow pigment, by the action of nitrous acid upon an alcoholic solution of rosaniline.

The formula of aniline yellow is $C_{20}H_{19}N_2O_6$.

Aniline Black.

A deep aniline green, which was formed by the oxidizing agent's use upon aniline oil, was first observed by Dr. J. Von Fritzshce, as early as 1842. It was formerly prepared from residues left after the preparation of aniline violet with bichromate of potash; but now aniline black is obtained by the action of chlorate of copper and chlorate of potash upon hydrochlorate of aniline (fuchsine), as is recommended by Lightfoot, who discovered the process. The advantage of his process is, that the dye or the paste for printing will not corrode the steel parts of the printing-machine, and that it will absorb enough oxygen to transform it into a sulphate of aniline.

It has been proved, however, by Cordillot, that the chlorate of potash and copper can be replaced by ferricyanide of ammonium. The black made by this process has to be printed upon the fabric.

Recently, the so-called Peterson's black has been obtained, its most valuable principle or property being that it is a ready-made black; and to fully develop it, it requires a slight oxidation. This aniline black is a black fluid mass of hydrochlorate of aniline and acetate of copper. It is mixed with thickening composed of either starch, dextrine, or gum arabic, and then printed upon the yarn or cloth. After printing it has to be oxidized by exposing the fabric to the atmosphere; the oxidation can be rendered more quickly by placing the fabric in a room, with a temperature of about 45°. The color will appear at its true shade after washing. Care will have to be taken that the fabric is dried directly after

printing, as, if the cloth is left and folded up, there is danger of spontaneous combustion.

Aniline black, as yet, has not been prepared so as to be a permanent color on wool or woolen fabrics, but the time is not distant when some method will be discovered, so as to make it as permanent a color on wool as any of the other aniline dyes.

Aniline brown, or Habana brown, is made, according to De Laire, by heating aniline blue or aniline violet with fuchsine at 140°, until the mixture is of a brown color. The brown obtained in this manner is very soluble in water.

The Bismarck brown, so called, is obtained by fusing fuchsine with dry aniline oil at a temperature of 450°. The operation is complete when vapors of a yellow color make their appearance, as the mass is suddenly transformed into brown when these vapors appear. This brown is also soluble in water.

Until within the last ten years, anilines were not soluble in water; and at the present time we receive them as soluble in water and soluble in alcohol.

CARBOLIC ACID COLORS.

In distilling coal-tar for the purpose of obtaining aniline, we have mentioned that there were two kinds of oil obtained, designated by the names of light and heavy oils, and that from the light oils benzole was obtained. Carbolic acid is prepared from the heavy oil, which boils over at 170° to 200°, during the manufacturing of benzole, toluol, &c., from tar. It is called phylic acid, phenol by some chemists, and others call it phenic acid, which appears to be the most correct term, for this reason: If aniline is an amide of the radical phenyl, and is often called phenylamine, phenic acid must be closely related to it, being an oxide of phenyl, and aniline being

already found formed in coal-tar, proceeds from the re-action of phenic acid upon ammonia, which is always produced by the decomposition of bituminous coal, and this re-action takes place by pressure, or by an elevation of temperature, or by both of these; and if so, the formula is—

$$\underset{\text{Ammonia.}}{NH_4O} + \underset{\text{Phenic Acid.}}{C_{12}H_5O} = \underset{\text{Aniline.}}{C_{12}H_7N} + \underset{\text{Water.}}{2HO}$$

For these reasons we prefer the name of phenic acid to carbolic, although in the trade carbolic acid is the only name used for this substance.

Carbolic acid, as manufactured by Calvert & Co., C. Lowe & Co., as well as by other eminent firms, is a crystalline mass, which will become slightly red-colored by being exposed to the air. It fuses at about 35°, and boils at 188°. Carbolic acid is made by treating the heavy oils of tar with alkalies. Carbolic acid is soluble in thirty-three parts of water. Calvert's carbolic acid, such as is used for manufacturing the so-called carbolic acid colors, is prepared by cooling a mixture of the Laurent acid in water. At 4° a hydrate of carbolic acid is separated, and by elimination of water it will become *pure* carbolic acid, and will fuse at 41°. Carbolic acid is largely used, in its several degrees of purity, for such purposes as an antiseptic, disinfectant, &c.; yet more than one-half of all that is manufactured is used for obtaining such pigments and dyeing-materials as the following: 1. Picric acid. 2. Phenyl brown. 3. Grenat soluble. 4. Corraline. 5. Azuline.

Picric Acid.

This substance is also known as *carbazotic acid* or *trinitrophenylic acid*, and its formula is $C_6H_3,NO_2,3O$; Berzelius $C_{12},H_23No_5,O+HO$. Picric acid is obtained by the oxidation of carbolic acid by nitric acid. It is a yellow, crystallized substance, which is readily dissolved in hot water, but difficult in cold water; it is also soluble in alcohol. It is used for dye-

ing silk and wool yellow; also for green with iodine-green crystals, and for green with sulphate of indigo. (See recipes for greens.) In France there are over one hundred tons manufactured annually, but the greater part of it is used for making picrate gunpowder, or the powder used for the needle-gun. For dyeing purposes it has been the practice to use the soda-salt of this acid, under the name of picric acid or aniline yellow, instead of using the pure (or non-explosive) picric acid, and by so doing it has given rise to some very serious accidents in some of the dye-houses in England.

When picric acid was first prepared, it was obtained by mixing fine pulverized indigo with nitric acid (the acid first being diluted with seven or eight times its weight of water); a gentle heat was then applied to the mixture, which dissolved the indigo with effervescence, forming a yellow-colored liquid. This was allowed to stand for a short time; it was then decanted from any resinous matter formed during the operation; then it was concentrated by evaporation, depositing a quantity of yellowish-white crystals of a sourish-bitter taste, and requiring nearly one hundred parts of cold water to dissolve them. This at the time was called indigotic acid, but now called anilic acid, from the name of a plant that yields *indigo anil.* This acid will combine with all known bases, forming generally yellow-colored salts, and gives a blood-red color to any solution of the per-salts of iron.

If indigo is added to concentrated nitric acid, and heat applied to it, the indigo is quickly dissolved, and at the same time a large amount of nitrous gas evolved. When the liquid has become cold, a great amount of semi-transparent yellow crystals are formed, which have a bitter taste.

These crystals were formerly called carbazotic acid, but now called picric acid. To procure picric acid in a pure state, the crystals that are obtained by the above acid are washed in cold water; then boiled in enough water to dissolve them; the liquid is then filtered and allowed to cool, when it will again crystallize in brilliant yellow prisms. This acid

can also be obtained by the action of nitric acid upon anilic acid. At the present time picric acid is not obtained by any of the above methods, being now obtained from carbolic acid only. This picric acid, made from carbolic acid, readily crystallizes, and will explode when heated. It is poisonous when taken in large doses, ten grains having been known to kill a dog in less than two hours. It was first used as a medicine for intermittent fever by Dr. Bell of Manchester, Eng., and he thought that it could be employed as a substitute for quinia. The salts which picric acid forms with soda or potash, are yellow-colored and very bitter, and are called picrate of potash, and are capable of violent explosion from a severe blow or from an elevated temperature, and in 1869, a very fatal consequence occurred from an explosion of a large amount of it, in one of the magazines in Paris, where it was stored.

Picric acid in its constitution is very permanent; it is not decomposed by being fused with either iodine or chlorine, neither will a solution of chlorine affect it. Sulphuric acid when hot will dissolve it, but when cold it has no action upon it. Nitro-muriatic acid (*aqua regia*) dissolves it with difficulty; boiling muriatic acid does not act upon it.

Picric acid is a test for potash in any fluid; a solution of it made in alcohol produces a bright yellow crystalline precipitate. Its formula according to Berzelius is, $C_{12},H_2 3NO_4, O+HO$, being phenylic acid, with three equivalents of hydrogen replaced by three of hyponitric acid.

Phenyl brown, *Phenicienne* or *Rothine*, so called from its discoverer, Roth, was first made by him in 1865, by causing nitric acid and sulphuric acid to act upon carbolic acid, the substance obtained being phenicienne or phenyl brown, which is an amorphous powder, a mixture of two pigments; viz., a yellow and a black-brown substance, which is similar to the humus compounds. It is brown-colored, soluble in alcohol, alkalies, and acetic acid, but of little solubility in water, either hot or cold. It produces permanent colors, and the shades obtained vary according to the

mordants used, but like the grenat brown will not stand the steaming process.

Grenat brown, grenat soluble. This has recently been introduced by J. Castbelaz in Paris, as a substitute for *orseille*, but is nothing more than the well-known isopurpurate of potash ($=C_8H_4KN_5O_6$), which was first discovered by Hlasiwetz, and is formed by gradually adding a solution of picric acid to a solution of cyanide of potassium. By this operation prussic acid and ammonia are evolved, and the purpuric acid will crystallize when the solution becomes cold. This substance is sold under the name of *grenat brown* and *soluble ruby*. As this substance when perfectly dry, is explosive with the least friction, it is kept in paste, to which is added a quantity of glycerine sufficient to keep it moist. With a zinc mordant it colors wool a beautiful yellow, and with corrosive sublimate a magnificent purple.

Coralline, sometimes called *Peonine*, is a scarlet-dye material, and was discovered by J. Persoz, and is formed, according to Kalbe and Schmidt, by mixing together carbolic, oxalic, and sulphuric acids, and heating the mixture in a closed vessel, at a temperature of 300° until the color has been sufficiently developed. When the re-action is finished, the mass is then washed in boiling water; this is done for the purpose of eliminating the excess of acid. They next dry the residue, pulverize it, and submit it at 150° to the action of ammonia. Coralline is soluble in alkaline solutions, acetic acid, and alcohol. It does not produce a very permanent color.

The existing relation between rosalic acid ($C_{20}H_{16}O_3$), which was discovered in tar by Runge, and coralline, is not yet fully established. Rosalic acid is formed by heating together twenty parts of phenic acid, fifteen parts of oxalic acid, and twelve parts of sulphuric acid. This acid is insoluble in water, but soluble in ether and alcohol. It can be formed from carbolic acid and creyslic acid (C_7H_8O), as rosaniline is formed from aniline and toluidine.

Azuline (Phenyl Blue).

This substance is formed by heating commercial aniline and coralline together, taking five parts of coralline and seven parts of aniline, and was first obtained by J. Persoz and Guinon-Marnas. It is a blue pigment, and is termed azuline or azurine.

It has been attempted to prepare pigments directly from nitro-benzole. Laurent and Casthelaz state that a red pigment is obtained by keeping a mixture of twelve parts of nitro-benzole, twenty-four parts of iron-filings, and six parts of muriatic acid, for thirty-six hours at the common temperature of the atmosphere. In this method there is formed a solid resinous mass, which is first exhausted with water, and the solution precipitated with common salt. The pigment which is thus obtained is said to be a good substitute for fuchsine, and is capable of being used as a dye, and for calico-printing.

Naphthaline ($C_{10}H_8$).

This material was discovered, in coal-tar, by Garden, in the year 1820, and was afterwards the subject of investigation by Faraday and Hoffmann, Ballo, and others, and has been the profound study of Laurent.

Naphthaline is a white, shining, crystalline substance, and is fusible at 176°, and boils at 423°. Its specific gravity, according to Kopp, in the liquid state, is, 0.9774; according to Alluard, at 210° it is 0.9628. It is soluble in ether, alcohol, naphtha, and is insoluble in water. Its odor is peculiar, and somewhat similar to storax, and it has a burning taste. When cool, after having been fused, it appears as a white, crystalline mass, and then has a specific gravity of 1.151. When treated with nitric acid, naphthaline yields phthalic acid ($C_8H_6O_4$), which, according to circumstances, and by elimination of carbonic acid (H_2CO_3), may be either converted into benzole (C_6H_6), or into benzoic acid ($C_{14}H_5O_3+HO$).

"There exists between the derivatives of benzole and naph-

thaline a great analogy, which not only extends to the composition and re-action, but even to chemical and physical properties. The analogy of composition is exhibited by the following tabulated form: —

"Benzal (hydride of phenyl), C_6H_6.
Nitro-benzole, $C_6H_5(NO_2)$.
Aniline, C_6H_7N.
Rosaniline, $C_{20}H_{19}N_3$.
Naphthaline (hydride of naphthyl), $C_{10}H_8$.
Nitro-naphthaline, $C_{10}H_7(NO_2)$.
Naphthylamine, $C_{10}H_9N$.
Base of naphthaline red, $C_{30}H_{21}N_3$."

Naphthylamine ($C_{10}H_9O_3$) is a base which corresponds to aniline, and it is prepared from naphthaline in exactly the same way as aniline is from benzole, by converting naphthaline into nitro-naphthaline by the aid of nitric and sulphuric acids, or nitro-sulphuric acid. It is then converted into naphthylamine. This crystallizes in white, acicular crystals. It fuses at 50°, and boils at about 320°. Its taste is a sharp bitter, and is almost insoluble in water, when heated with arsenic acid (A_3O_5), or with nitrate of mercury. It produces a fine purple dye, which, however, is not fast. Naphthylamine, also, serves to prepare such dyes as the Martius yellow, naphthaline violet, magdala red, and naphthaline blue.

The Martius yellow is better known in England as *Manchester yellow*, or *naphthaline yellow*. Its formula is $C_{10}H_6(NO_2)2O$. This dye is obtained by heating hydrochlorate of naphthylamine with nitrate of soda, and afterwards with nitric acid. This dye imparts to wool or silk, without the aid of any mordant, yellow hues, which may be made to differ, in depth of color, from a lemon-yellow to a deep golden-yellow. The discoverer of this dye (Dr. C. A. Martius) considers it to be an acid analagous to picric acid, and calls it *binitro-naphthylic acid*. Picric acid yellow will not admit of

the steaming process, while the Manchester yellow will admit of the steaming operation. The dye is used in America for the purpose of modifying the hue of magenta.

Magdala red. This pigment, which is naphthaline red, was discovered by Von Schiendl of Vienna in 1867. This substance has been subject to the researches of such eminent chemists Durant, Kestner, Hoffmann and others. It is generated naphthylamine by the elimination of three molecules of hydrogen from three molecules of the base; thus —

$$\underset{\text{Naphthylamine.}}{{}_3C_{10}H_9N} - \underset{\text{Water.}}{{}_3H_2O} = \underset{\text{Magdala red.}}{C_{20}H_{15}N_3}.$$

"On the large scale the manufacture of magdala red is produced in two stages. In the first instance the naphthylamine is converted into azodinaphthyl-diamine by the action of nitric acid, thus —

"First stage: —

$$\underset{\text{Naphthylamine.}}{2C_{10}H_9N} + HNO_3 = \underset{\text{Water.}}{2H_2O} + \underset{\text{Azodinaphthyl-diamine."}}{C_{20}H_{15}N_3}.$$

"In the second stage the azodinaphthyl-diamine is treated with naphthylamine, the result being the formation of the magdala red."

The re-action may be represented by the following formula:

$$\underset{\text{Azodi-naphthyl-diamine.}}{C_{20}H_{15}N_3} + \underset{\text{Naphthylamine.}}{C_{10}H_9N} = \underset{\text{Magdala red.}}{C_{20}H_{21}N_3} + \underset{\text{Ammonia.}}{NH_3}$$

The magdala red we find in the trade is of a black-brown color and is a crystalline powder; it is the chloride of a base in the composition above described. In regard to its coloring power, it is no less valuable than fuchsine or magenta, and it surpasses fuchsine in its permanency. When magdala red is

treated with iodide of methyl and iodide of ethyl, naphthaline red yields violet and blue colors.

Naphthaline Blue and Naphthaline Violet.

"Blue and violet naphthaline pigments can be prepared by various methods; for instance, by treating naphthylamine with nitrate of mercury ($HgO_2 2NO_5 + 1CHO$)." *

Wilder obtains these dyes by substituting the radical naphthyl for the hydrogen of the aniline and toluidine. J. Wolff, in 1867, obtained a very brilliant naphthyl blue in this manner. M. Ballo did the same from rosaniline and mono-bromnaphthaline, also from rosaniline and naphthylamine.

Very recently Blumer-Zweifel, and Kielmeyer have colored naphthaline violet on cotton and linen cloth by treating naphthylamine (which was previously painted upon the cloth) by immersing the fabric in a solution of chlorine of copper and chloride of potash, and by such other re-agents as may be employed for producing an aniline black.

The coloring of aniline-black upon wool has not yet been successfully produced, the nearest result being the chlorine process of Mr. Lightfoot. Recent experiments that have been made lead us to hope that aniline black will be employed on wool as well as on cotton, with the same results as to its permanency. Aniline black, prepared either with bichromate of potash or chlorate, will color wool a fast gray. There are two processes now employed to fix this color upon cotton. Messrs. Paraf and Javal pass the cotton fabric through a bath which contains a mixture of sulphate of aniline and bichromate of potash; by this process the color will appear upon the fabric as soon as it is taken out of the bath; but the temperature of the bath will have to be kept at about 30° Fahr., and not above the freezing-point.

The other method consists in first passing the cotton through

* This salt is a nitrate of peroxide of mercury, and should be represented by this formula, HgO,NO_5, independent of water of crystallization. — G.

a bath containing chromate of lead, and then through an acidulated bath of oxalate of aniline. In this process the reaction, taking place only upon the cloth, the temperature has not to be so low as by the other method. (See article, Improvement in Aniline.)

For the improvements and new discoveries in colors derived from coal and its products, see the translation from the report of the Universal Exposition at Vienna in 1873. (See article, Improvement in Aniline.)

A BRIEF HISTORY

OF THE

DISCOVERY OF COLORS DERIVED FROM COAL.

The manufacture of coloring-materials derived from coal is of recent date (1856). It is to Perkins, the young English chemist, that the honor of this discovery and industry belongs. Perkins, while trying to obtain artificial quinine from coal, by the re-action of an oxidizing agent upon the sulphate of aniline, obtained some violet, which he separated from a black mass that did not appear to offer much of interest. This color immediately produced a great sensation in industry, because of its incomparable brilliancy, its solidity, and the source from which it was derived. A magnificent and brilliant color extracted from black and dull pit-coal. There was an opposition which aided powerfully in spreading the news of this great discovery. The price of this coloring-material was so high that few dyers and manufacturers believed in its future employment ($445 per pound, avoirdupois).

The discoverer himself hesitated much about inaugurating the manufacture of this color, and he was anticipated in the production of this coloring-material in large quantities by several French manufacturers, among whom were Mons. Poirrier and Chappat, Jr., who brought some modifications to Perkins's process. To make this new violet, the difficulties were very great indeed. The patent obtained by Perkins indicated very plainly the process for obtaining this color (re-action of the bichromate of potash upon the sulphate of aniline). But although aniline was known to the savants,

who possessed some grains of it in their laboratories, it was but little known to manufacturers. There were no makers of aniline.

The scientific works were consulted, and it was then ascertained that the most advantageous method of obtaining aniline, was that of preparing it by means of nitro-benzine. This last product was not made much more than aniline, although Collas and Laroque were making some few pounds of it, which they sold for perfumery, under the name of essence of mirbane. All, then, was to be created: manufacture of aniline, manufacture of nitro-benzine. It was not quite necessary for them to organize for the manufacture of benzine. Benzine had, up to that time, only very restricted uses. It served for the cleansing of goods, and was sold under the name of "Collas benzine." Inquiry was made at the gas-factories for benzine; and the manufacturers of colors finding at those places an almost inexhaustible repository of raw material, brought to these factories a source of profits, and, at the same time, disembarrassing them of an encumbering product (coal-tar). It was the English manufacturers who first began to distil their oils. All that part of the business was rapidly created. In less than three years this multiple industry of coloring-materials derived from coal-tar was on its feet. It was soon in operation upon the largest scale in France, in England, then in Germany.

The manufacture of nitro-benzine, notwithstanding the difficulties and dangers of explosion and conflagrations which it presented in the beginning, did not prevent the manufacturers in France or in England from making it. The manufacture of aniline was established after a process discovered by Bechamp, a French chemist, which was the only one practicable among the various processes then indicated, and which is to this day followed for its manufacture by all the manufacturers of aniline. Industry made a large application of the processes which were furnished to it by science.

Aniline, which was hardly known, and which was pro-

duced at first at the price of 150 francs the kilogramme, fell rapidly to 25 francs per kilogramme.*

"From the day that aniline was produced at twenty-five francs it became certain that the aniline colors would receive the greatest development.

The investigators, stimulated by the profits which was judged would accrue to those who first engaged in its manufacture, set themselves to the work; and in 1859, Verguin, industrial chemist at Lyons, created the manufacture of aniline red. This red had been seen some months before by Hoffmann in his scientific investigations of aniline. To Verguin belongs the credit of the industrial creation of the manufacture of aniline red. He carried his product and his process to Messrs. Renard Bros. (at Lyons), dyers, who had the product and process patented.

"The appearance of the red produced a sensation not less than that occasioned by the discovery of the violet by Perkins. The price was likewise high, 1,200 francs the kilogramme ($223.20 per $2\frac{1}{5}$ lbs. avoirdupois), for a product less pure than that which is sold to day for $7.50 ($2\frac{1}{5}$ lbs.) This red had more brilliancy than the violet. There was no red that could compare with it. Messrs. Renard Bros. gave to it the name of *Fuchsine*, and it was seen most in the color called magenta, made with this new red.

"Verguin had not, in his first experiment, used the best agent for the transformation of aniline into red; and many other agents, which, as a general thing, gave more advantageous results, were soon discarded; but all originated from the same chemical re-actions; viz., elimination of the hydrogen in the aniline and final formation of a salt with the same base, the composition of which Hoffmann determined some time afterwards, to which he gave the name of *rosaniline*, and gave it this formula—$C_{20}H_{19}Az_3H_2O$.

"There were numerous processes, and all the tribunals

* It is now selling for two francs per kilogramme (two and one-fifth pounds avoirdupois.)

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judged in the same way. They saw no novelty in substituting one agent for another, re-acting upon aniline, to arrive at the same product; so they granted to Renard Bros. the proprietorship of the aniline red, which they had first manufactured and used industrially.

"Unfortunately the patentees did not understand sufficiently that every right imposes a duty. They allowed too great a difference to be established between the prices of their products and those of foreign manufacturers, and they soon saw foreign competition, in defiance of their patents, invade the French market. From France, where the red was discovered and first manufactured, it at once spread into England and into Germany; and instead of the history of the violet discovered being of English origin, it soon became entirely French; the red, discovered in France, seems, rather, born in Germany from the great number of factories which immediately sprang into existence in that country for the manufacture of this red.

"The red soon gave way to a very important manufacture. It soon served no longer only for coloring in that beautiful shade, magenta, which every one knew, but it became the raw material for all other aniline colors, — blues, violets, green, garnet, &c.

"The red had been scarcely discovered two years before those two young French chemists, Girard and De Laire, discovered that it could be transformed into a violet more beautiful even than the Perkins violet, and into a magnificent blue, by heating it with aniline. These chemists brought their process to Renard Bros., and their blue replaced, in most of their applications, the French blue and the indigo carmine.

"About the same time, Guinon, Marnas, and Bonnett manufactured a blue called azuline, but it could not sustain the competition of the aniline blue.

"There could not, after this, be any halting in the path of discoveries. After the blue came the green, obtained, like the blue, from the red, by way of an unstable blue discovered by

Charles Lauth, who obtained it by causing aldehyde to re-act upon the red.

"This green was found by Cherpin, employed at Usebe. Cherpin wished to fix the aniline blue of Charles Lauth, which, up to that time, had no application on account of its instability. Acting upon the advice of a photographer (who was a friend of Cherpin), who deemed the hyposulphite of soda the *universal fixer*, he employed the hyposulphite of soda to fix the aldehyde of Charles Lauth, as a photographic proof is fixed.

"What must his astonishment have been to observe the blue transformed into a green,—a green that was perfectly fast.

"This shade of green was immediately employed by the silk-dyers, to the exclusion of all other shades of green. This green-dye gives very good results in calico-printing, but it does not answer so well for wool-dyeing. We have now seen the red transformed into violet, into blue, and into green. Hoffmann followed these discoveries, and, by a new process, he made this red undergo another change. He submitted it to the action of an alcoholic radical, and he obtained the violet, which now bears his name.

"In the same manner that Girard and De Laire obtained the imperial violet and the blue, by substituting one or more molecules of the phenyl radical (C_6H_5) contained in aniline, for one or more molecules of hydrogen of the rosaniline, so Hoffmann substituted the radicals of the alcohols (ethyl, C_2H_5, methyl, C_1H_3, &c.), in this same rosaniline.

"At this time we had several violets, the Perkins violets, and those of Girard and De Laire. The Hoffmann violet, however, was none the less welcomed with the greatest favor, it being much more brilliant than its predecessors.

"The manufacturers of the violets ascertained that in preparing the Hoffmann violet, green was formed. This green was isolated from the violet, and the dyers of silk and cotton abandoned the use of the aldehyde green, and used only this

new green, called iodine green. This green is more beautiful than the aldehyde green, but not so permanent as the last named. The Hoffmann green remained for a long time at a high price, two hundred francs per kilogramme ($37.20 per two and one-fifth pounds avoirdupois), for which reason it did not come into general use. Next came the Paris violet, and through this violet, we obtain colors which are no longer obtained by means of the red, but are derived more directly from aniline.

"There were great exertions made to obtain similar colors, which should be different in composition from those obtained with rosaniline, and at the same time compete with them in brilliancy and cheapness. This is the problem which Poirrier and Chappat, Jr., have solved, by introducing the Paris violet. The methylaniline violet, called the Paris violet, had been indicated as long ago as 1861, by Lauth. For various causes, this chemist did not follow out his discoveries. It was in 1865 that Poirrier and Chappat, Jr., with the co-operation of their chemist, Charles Bardy, undertook to make violet derived from aniline, into which they should have introduced previously an alcoholic radical. The greatest difficulty was to manufacture industrially these alkaloids from alcoholic radicals, by a practical process, and at a price which should enable them to obtain a violet not costing more than the Hoffmann violet. The process indicated and followed in the laboratories, to obtain methylaniline or ethylaniline by the re-action of the alcoholic iodides, became exclusively dear, and the process was not practicable industrially.

"Here, again, industry came to borrow from science. The process indicated by Berthollett, for the substitution of an alcoholic radical in ammonia, by heating the radical, under pressure, with chlorhydrate of ammonia, was applied to aniline.

"The operation was delicate and dangerous; it required an apparatus strong enough to resist a great pressure, and so constructed that no gas could escape. Up to this time the

use of close vessels had not been adopted in industry. All precautions were taken; there was no accident to deplore, and after great perseverance and expense, the result was accomplished."

"To-day, even industry begins to employ this method of closed vessels. It appropriates to itself the processes of science, modifying them for its own use. It is by this process that it has been proposed to saponify fat substances by pure water, at a temperature near 200°. Although the immense pressure produced under these circumstances, has made it necessary to relinquish the action of water upon fatty bodies, used in all its simplicity, nevertheless this re-action has been made to co-operate successfully in the saponification of neutral fatty substances, by employing at the same time as the water, a small quantity of lime, which enables the operation to proceed at a lower temperature, but always with the assistance of the close vessels.

"Messrs. Poirrier and Chappat were more daring, when they applied the method of close vessels to the preparation of methylaniline, by the re-action of methylic alcohol upon the chlorhydrate of aniline, and conformably to a scientific process noted by Mons. Berthollett, for the production of organic alkalies. The methylaniline prepared by their process, and the beautiful violet coloring-material which is obtained from it, appeared at the Exposition. These first attempts may be regarded as the prelude of discoveries which await industry in a new and fruitful path."—*Extract from the Report of Mons. Berthollett, Universal Exposition of 1867: The methods of close vessels and its applications.*

"As we see, the process of Messrs. Poirrier and Chappat, is double. It comprises in one part, the manufacture of ethylic and methylic derivatives of aniline; and, in the other, the transformation of these secondary monamines into violet coloring-materials. The method which they have adopted for producing methylaniline and ethylaniline, is that which Mons. Berthollett had indicated for producing, in a general manner, the monamines from alcoholic radicals.

"This is a new example of the passage of scientific methods into industrial art; and a remarkable circumstance, of all those methods which had been employed for the preparation of methylic and ethy-

lic alkalies, this, which seemed the least practical in the laboratory, is the only one which has become industrial."—*Extract from the Report of A. W. Hoffmann, De Laire, and Charles Girard: Coloring materials derived from coal. Universal Exposition of 1867.*

Methylaniline being obtained, it remained to choose the most suitable agent for transforming it into violet; these agents are numerous, but they do not all give good results. Poirrier and Chappat, Jr., were transforming this base into violet by a process original but costly, when Charles Lauth succeeded in replacing it advantageously. From that time the *Paris violet* could be furnished at a price quite low.

The following is abridged from the report of Mons. Balard, in relation to the discovery of new colors by A. Poirrier and his chemists:

"In 1861 Mons. Lauth, by oxidizing methylaniline, obtained a *new* violet, the manufacturing of which he relinquished, an account of the great difficulty there was in preparing the raw material. But this study was taken up by Messrs. Poirrier and Chappat, with the assistance of their chemist, Mons. Bardy. These chemists and manufacturers of these new dyes have not only succeeded in making methylaniline under conditions of extremely low cost, by imitating a process which had served Mons. Berthollett for obtaining the alcoholic ammoniacs of Mons. Hoffmann, but they have found out how, by a suitable oxidizing action, to transform this substance into a violet wholly new, into a methylaniline violet. This violet, which differs from the violet (in some of its properties) obtained from rosaniline, necessarily differs from it in its constitution, it being produced from the purest aniline that industrial art can furnish.

"In 1861, to the manufacture, in large amounts, of the product which he had discovered, Mons. Lauth succeeded in bringing, in his turn, a most useful means of assistance. By causing the introduction of heat to aid the oxidizing action of the air, and of other more energetic agents of oxidization,

he has been able to produce, with one hundred parts of methylaniline, more than forty parts of a violet, obtained under the most economical conditions, and whose use begins already to spread in Europe and America." [This report was made in 1867.]

NOTE.—Methylaniline had never been made, except in the laboratories, and then only by means of the re-action of iodide of methyl upon aniline, as indicated by Hoffmann, until the present process was discovered at Poirrier's establishment. Even dimethylaniline had never been indicated.

To-day, in most factories for making these dyes, in all countries, methylaniline violets and greens are produced by the processes of Poirrier and his chemists. Their competitors welcomed the communications which unfaithful chemists and overseers, attached to their (Poirrier's) house, made known to them.—G.

"This last violet dye (the Paris violet) gave shades which were identical with the Hoffmann violet, and the product was sold at one hundred francs ($18.60), while at the same time the Hoffmann violet was valued at two hundred francs ($37.20) per kilo. ($2\frac{1}{5}$ lbs. avoirdupois). The Hoffmann violet was an iodhydrate, insoluble in water, soluble in alcohol, which increased the price still higher; whereas the Paris violet was soluble in water. The Paris violet, at its first appearance, was not equal to the Hoffmann in brilliancy, but it is now used by woolen-dyers in preference to the Hoffmann, as it gives more pure and clear shades, besides being more permanent.

"A. Poirrier is manufacturing large quantities of this violet, and there are no other firms who are regularly carrying on the manufacture of this particular violet."

"There is another color obtained directly from aniline, but it is not what is termed a product which is prepared in the factories of chemical products and delivered to the dyers and printers, but a color that is applied, colorless, upon the fabric, and, by exposure to the atmosphere and certain agents, it develops itself upon the fabric; this is the aniline black.

"This aniline black has been, up to the present time, exclusively employed in printing upon cotton. This color, con-

trary to all the others derived from aniline, resists completely the action of the light.

"There was at first no process for applying it to *dyeing*. Charles Lauth, however, discovered a process whereby he could render Lightfoot's process of application, by printing, practical. Before this improvement, brought by Lauth to Lightfoot's process, it had not been possible to make use of the black, as the agents that Lightfoot employed attacked the vegetable fibre. (See page 461.)

"We obtain with aniline, either directly or by passing through the red, red at first, then blue, violet, green, and black. We obtain, also, other colors, but these are of less importance than the above colors; for instance, the grays, the browns, the oranges (which are produced at the same time as the red, which they tarnish and from which we separate them). Some deep blues are obtained, which for some uses replace, in a measure, indigo.

NOTE.—All the colors thus far are derived from aniline, but in distilling the coal-oil we obtain, besides the benzine, many other substances, and among them are some which also serve to generate colors,—such as phenic acid, naphthaline, and anthracene.—G.

"Phenic acid is a source of several coloring-materials; one of them, picric acid, has been known for a long time. It was manufactured long before the appearance of aniline colors. (See article on Picric Acid in another part of this work.) Messrs. Guinon, Marnas, and Bonnett first made it and applied it to the coloring of silk. It gave a clear yellow, very brilliant."

"The manufacture of coloring materials derived from coal, though in its infancy yet, has already taken one of the foremost places, through the importance of the transactions to which it has given rise.

NOTE.—A business estimated at not less than $11,160,000 per annum.—G.

"More than every other industry, it keeps the manufacturer of colors derived from coal constantly employed, either to

perfect his processes or to discover new ones. This business progresses and transforms itself with astonishing rapidity.

"We can judge of this by what has occurred during its brief existence; a product such as seemed at one time to defy all competition, was afterwards completely superseded by a product quite superior to it. Thus the Perkins violet was only brought into use in 1859, and in 1861 there appeared the imperial violet of Girard and De Laire.

"Three years scarcely elapsed before the Hoffmann violet took the place of the imperial violet; this was succeeded by the Paris violet two years afterwards, whose introduction diminished the demand for Hoffmann's violets to a great extent.

"What has come to pass as to the violet, has happened in like manner to the other colors, — the green and blue. The iodine green has replaced the aldehyde green, the soluble blues have replaced, in part, the alcoholic blues, and the consumption of the soluble blues is continually increasing.

"The transformations are so rapid, that the manufacturer of these colors has, we might say, no certainty of the morrow for the product which he manufactured yesterday. Apart from the discoveries which are born, and which overturn anterior discoveries, he is not up to the simple improvements which may overthrow his last-manufactured color. And then, in the same color, there must be varieties as numerous as the consumptions for which they are prepared. Thus, a kind such as is applied by the calico-printers, will not be valued by the dyers. In the same manner, silk-dyeing employs another kind from that of wool-dyeing; and their demands are so much the more exacting, because success depends upon the good quality of the coloring-materials employed in them."

NOTE. — Unless the dyer has materials sufficiently pure, he cannot, with all his skill and experience in applying them, produce shades that will have the intensity and brilliancy which is wanted. — G.

Aniline colors, besides being easily applied, have a great affinity for textile fibre, and are generally applied to wool without the use of a *mordant*, it being only necessary to immerse the wool or yarn in a solution of the aniline dye. By giving the wool or yarn a preparation either of bichromate of potash, alum, glauber salts, or silicate of soda, we will obtain a very permanent color with these dyes (see Recipes for Aniline Colors).

"The prices for these dyes were formerly very high, but to-day are very low. Formerly, fuchsine cost twelve hundred francs a kilogramme ($2\frac{1}{5}$ lbs.); it is now sold at fifty francs for the same amount, and the quality at the present day is far superior to what it was then. The bichromate violet, which was sold at one hundred and fifty francs in the form of paste, is now sold at twenty francs a kilogramme ($2\frac{1}{5}$ lbs.). The aniline itself from which these dyes are made, and which was then valued at twenty francs, costs but five francs now a kilogramme."

"The following table gives very nearly the relation which exists between the figures that represent a given weight of mineral coal (say one ton), and that of the aniline red which can be produced from it, as well as the relative quantities of all the intermediary products: —

Coal, 2,200 lbs:

Coal-tar, ...	220 lbs.	
Benzine, ...	2 "	32 gr.
Nitro-benzine, ...	2 "	12 "
Aniline, ...	1 "	14 "
Aniline red, ...	0 "	8.8 "

(See a description of these articles in another part of this work).

PREPARATION OF RAW MATERIALS DERIVED FROM COAL, WHICH ARE EMPLOYED IN THE MANUFACTURE OF COLORS.

"The coal is first submitted to distillation in underground retorts, which are heated to redness by a vertical flue placed upon the upper part of the retort. The gas is set free at the same flue as the oleaginous product, which is deposited by cooling, and drains into large vats. The gas pursues its way in the flues, and after purification, enters the reservoirs, from which it is distributed for illuminating purposes.

"The oleaginous product is the tar, which is produced in large quantities, and still, to-day, encumbers certain manufactories that do not distil it. Coal-tar contains a number of chemical products, which are separated by distillation, and by appropriate treatment.

"Among them we shall cite only those which interest us, and which are utilized for the production of colors, which are the following:—

Benzine (C_6H_6).	Toluene (C_7H_8).
Xylene (C_8H_{10}).	Anthracene ($C_{14}H_{10}$).
Naphthaline	Aniline (C_6H_7Ag).
Phenic, or carbolic acid (C_6H_6O).	

Benzine — Toluene — Xylene.

"The product sold in commerce under the name of benzine, is nearly always a mixture of benzine, toluene, and xylene, and it is this mixture, in variable proportions, or at least a mixture of benzine and toluene, which is generally employed in the manufacture of colors.

"Benzine, in the state of purity, is a colorless volatile oil, boiling at the temperature of 80°. It is less dense than water (its density being 0.850), and very inflammable, and when on fire, cannot be extinguished with water, as it will swim on the surface. It becomes solid at zero. It was dis-

covered in 1825, by Faraday. Dr. Hoffmann noted its existence in coal-tar in 1845. To separate the benzine from the various products with which it is mingled in the coal-tar, they proceed, as we have said, by distillation, separating the light products; that is to say, those which are less dense than water, from the heavy products.

"They re-distil several times these light products, after having treated them with sulphuric acid, and they have then a limpid, colorless oil, which contains a mixture of benzine, toluene, xylene, &c. By fractional and repeated distillations, or by a single distillation in an apparatus suitably arranged, they separate these various substances. That which passes over at the lowest temperature, is the benzine, which boils at 80°, then the toluene at 110°, the xylene at 130°." (It was Mansfield that pointed out the existence of toluene in coal-tar, in 1847; its density is about 0.840.) "Although toluene resembles benzine, it differs from it in several of its properties. Toluene is found in balsam of tolu. If the balsam is distilled to dryness, the distillation give a mixture of benzoic ether and of toluene.

"Xylene was found by Cahours, in 1850, in the oil which is separated from raw wood spirit, by the addition of water. It plays a much less important part than benzine and toluene in the formations of colors; we will, therefore, no longer dwell upon it.

"Nitro-benzine: The product sold under this name is almost always a mixture of nitro-benzine and nitro-toluene. It was discovered in 1833, by Mitscherlich. It is an oily liquid, of a light amber color; its odor is that of the essence of bitter almonds. It solidifies at 3° below zero. It boils at 213°. Its density is 1.209. It is inflammable.

"Nitro-toluene has many of the physical properties of nitro-benzine. It boils at 225°, and its density is 1.180.

"Nitro-benzine and nitro-toluene are obtained by causing fuming nitric acid to re-act upon the two hydrocarbonates.

"This operation is not always without danger; and at the

commencement of using these substances to attain dyes, there were numerous accidents and explosions, accompanied with conflagrations occasionally.

"When these substances were first manufactured, it was done in glass vessels, next in stone, but now in iron vessels. In an iron apparatus of a cylindrical form, with a capacity of two hundred and twenty to three hundred and thirty gallons, they introduce first the whole quantity of benzine that they wish to transform; then they set in motion an agitator with which the apparatus is provided, and cause a mixture of sulphuric and nitric acids to enter by a tube arranged for that purpose. The agitator is kept constantly in motion, so that the mixture of acid may come in contact with the whole mass, until it is all liquefied.

"They moderate the re-action, or render it active, either by applying cold water upon the walls of the apparatus, or by sending steam into a covering which surrounds it. When the operation is ended, they liquefy the product, which separates into two strata; the one oily, which is the nitro-benzine; the other is an acid mixture, weakened.

"The nitro-benzine has to be washed thoroughly with water, then with a small quantity of soda in the water, in order to neutralize the acid."

Aniline — Toluidine.

"These are the last products secured preparatory to obtaining most of the so-called aniline dyes or colors. The product sold by the name of aniline, is, generally speaking, a mixture of aniline and toluidine."

Aniline was discovered in 1826, by Unverdorben.* In 1833, Runge discovered that aniline yielded, when brought into contact with a solution of bleaching powder (hypochlorate of lime), a very beautiful violet color, hence the name kyanol (*blue coloring oil*).

* Unverdorben first discovered it among the products of the dry distillation of indigo.—G.

"Runge also discovered, in 1834, the existence of aniline already formed in coal-tar. Later, Hoffmann indicated processes for effecting its separation from coal-tar; but, unfortunately, it was obtained in this way in small quantities. It was Zinin who first discovered that nitro-benzine* could be transformed into aniline; and, later, Bechamp, perfecting Zinin's process of transforming, endowed industry with a practical process, just at the moment of the birth of the aniline colors, in 1859; a process which has contributed not a little to the great development which that industry at once received.

"Aniline is an oily product, slightly colored, and boils at 182°. It has a very strong aromatic odor, and is also a very energetic poison. It combines with acids, forming salts, which generally are soluble in water. Its density is 1.028.

"Toluidine is obtained like aniline, but by the reduction of nitro-toluene. It boils at 198°. Its density is about 1.012. It is solid at the ordinary temperature of the atmosphere, but it is nearly always mixed with pseudo-toluidine; and, in this case, it crystallizes only at a temperature below zero, separating itself from the pseudo-toluidine. Pseudo-toluidine (a body isomeric with toluidine) was discovered by Rosenstiehl. It is always formed at the same time as toluidine. Its boiling-point is the same as toluidine; many of their properties are common to both; but Rosenstiehl very skilfully succeeded in finding the re-actions which serve to characterize them; also the method of separating them. He has likewise indicated the part which each of these alkaloids plays in the manufacture of aniline red.

"Aniline, which was formerly prepared in a small apparatus, is to-day made in a large cast-iron cylinder, very nearly of the same shape and capacity as that used for the manu-

* In the year 1842, Zinin found that when nitro-benzine was treated with sulphuretted hydrogen, there was formed a base, which he termed benzidam. The further researches of Erdmann, brought the fact to light, that Underdorben's kyanol, benzidom, and aniline, were the same substance, to which the name of aniline was then finally given.—G.

facture of nitro-benzine, and likewise provided with an agitator (mixer). They pour in at first some very weak acetic acid; they set the agitator in motion, then they add a certain quantity of pulverized cast-iron, and all the nitro-benzine that they wish to transform.

"A lively re-action sets in; the vapors condense into a re-distiller, placed above the apparatus and in communication with it, and fall back into it continually; they add, little by little, new quantities of iron.

"When the nitro-benzine is transformed into aniline, as soon as they discover this, they draw out some of the liquid product, and if it entirely dissolves in muriatic acid, they then inject steam into the mass; and, in this manner, they carry away the aniline from it. They then submit this to a new distillation, and in this state it is employed for the manufacture of colors."

Methylaniline — Ethylaniline.

"These bases are compound anilines, that is to say, anilines in which a molecule of ethyl or of methyl has been substituted for a molecule of the aniline.* They are oily liquids, with a slight yellow color, and boil at a higher temperature than that of aniline. These bases are obtained in the factory of A. Poirrier, by a process original with him. Into an apparatus capable of sustaining a high pressure, they introduce a salt of aniline, the chlorhydrate, and the alcohol whose radical they wish to obtain; they close the apparatus hermetically, and then apply heat for some hours at different temperatures, according to the nature of the alcohol and its boiling-point, perhaps from 225° to 250°, and even 300°.

"When the operation is ended, they let the apparatus cool, then draw off the liquid; they have the chlorhydrate of the base, which they decompose by the addition of certain quantities of lime; they distil the whole over an open fire; they

* Hoffmann was the first to make these substitutions.—G.

separate the oily layer, and re-distil it again, separating the parts which flow over at a temperature between 190° and 210°, if it is methyl aniline which they are obtaining, and it is these parts which are used for transformation into colors. By the addition of bichloride of anhydrous tin, the methylaniline becomes at once a beautiful blue-violet color.

Phenic Acid — Naphthaline — Anthracene.

"Calvert was one of the first chemists who obtained phenic acid, industrially, in a state of remarkable purity. Phenic acid is a solid, crystallized substance, and is colorless.* It has the odor of smoke. It has a caustic and burning taste. Its density is about 1.065. It is much employed at the present day in pharmacy.

"To obtain it, it is necessary to collect the parts which boil over between 160° and 190°, when coal-tar is distilled. They then treat these with a lye of soda, quite weak. They thus obtain phenate of soda, which they decompose by sulphuric acid. They then submit it again to distillation, and the oily product, after having separated the heavier products from the lighter ones, is the pure phenic acid, which easily crystallizes.

"Naphthaline † is a solid, colorless, and crystallized product, having a strong odor of coal-tar. It boils at 220°."

"It is found in large quantities in the light oils of the distillation of the tar, after they have separated from the phenic acid. They have them in a solid mass, which they submit to the action of a press; the product thus pressed out, is submitted to sublimation, and the naphthaline thus obtained is quite pure; although its boiling point is very high, it sublimes easily."

* It becomes slightly reddened by exposure to the atmosphere. It fuses at 34°, and boils at about 180°.—G.

† This material was discovered in 1820 by Garden, in coal-tar, and was afterwards the subject of close research by Faraday, Hoffmann, Ballo, and others. According to Berthollett, it may be prepared by substituting for two atoms of hydrogen of the benzole, two atoms of acetylene.—G.

"Naphthaline, when treated with nitric acid, is transformed into nitro-naphthaline ($C_{10}H_7NO_2$), which, when reduced like nitro-benzine, is transformed into naphtylamine, a base analogous with aniline."

"Anthracene* is obtained by the process of Broenner, by submitting in a retort, either the resin of coal-tar or asphalt, to the action of superheated steam. When they distil the light oil of coal-tar, there remains at the end of the distillation a glutinous product, of an orange color, which contains much anthracene."

"In the foregoing remarks we have shown how they obtain tar from coal, the various products which they extract from this tar, the transformations which they caused certain of these products to undergo,—the benzine into nitro-benzine, and this last into aniline, this into methyaniline and into diphenylamine, &c. It only remains further for us to describe the method of obtaining the aniline *colors* from these products."

* This material was discovered in 1831 by J. Dumas, and was first employed by Graebe and Liebermann in 1869, for the purpose of obtaining anthracene red or artificial alizarine.—G.

PREPARATION

OF THE

VARIOUS COLORS DERIVED FROM ANILINE.

Aniline Violet, Mauveine, Rosolane, Indisine.

" The Perkins violet, to which the inventor gave the name of mauveine, in the form of a base, is also known by the name of Rosalane, Indisine, &c., names which have been given by different manufacturers.

" Mauveine or violet is, as we have said, the first color obtained industrially, and derived from aniline. This is a red-violet, less brilliant than the other violets which have been discovered since, but which has the advantage of being more solid in appearance. This dye can be obtained in the form of crystals of a fine brilliant green color, but it is generally found in the market in the form of paste.

" This violet is obtained by mixing cold, or nearly cold solutions of sulphate or chlorhydrate of aniline, and of bichromate of potash, equivalent for equivalent. As the process of mixing the two liquids goes on, a black precipitate forms, and the temperature rises. They leave the solutions in contact for some time, perhaps twenty-four hours; then they wash the precipitate thoroughly in cold water, to take away the salts which might impede solution. The black product being washed, they treat it with thirty or forty times its weight of boiling water; they stop the ebullition at the end of a certain time, perhaps one hour; then the black mass de-

posits, and the liquor is strongly colored violet; they then filter so as to separate the impurities which might remain in suspension, and they add to the filtered liquid a certain quantity of marine salt (common salt); this causes the violet dye to precipitate in a flaky form; they filter again; a water entirely colorless passes through, and the coloring material remains upon the filter.

"Perkins, in his patent, recommended the purification of the black mass by benzine, then drainage with warm alcohol. This mode of treatment, which is yet partially followed by certain manufacturers, requires the use of very costly apparatus, and has likewise, the inconvenience of giving less pure products, and they are obliged to re-dissolve them in water to get the purity they desire.

"On the nature of the aniline, and on the temperature at which the operation is carried on, depends the success of producing violet dyes, and it demands the greatest care to produce them, for the amount of product varies very quickly, to the extent of over or double itself."

NOTE.—The so-called violet imperial obtained by Girard and De Laire, by the action of bichromate of potash upon a mixture of aniline oil and hydrochlorate of rosaniline, differs from the above product.—G.

ANILINE RED, ROSANILINE ($C_{20}H_{19}Az_3H_2O$), FUCHSINE, ROSEINE, MAGENTA.

"Aniline red, like the Perkins violet, is sold under various names. It was Renard Brothers who gave it the name of fuchsine, from the German name fuchs, which means Renard (English, fox). Aniline red, which is a colorless base, designated by Hoffmann under the name of *Rosaniline*, is generally delivered to the consumer in crystals of a fine brilliant green color, which gives a magnificent red solution in alcohol, or warm water. The coloring-power of this material, like all other aniline dyes, is immense.

"With two and one-fifth pounds of aniline red, we can

color from twelve to fifteen pieces of merino (according to shade desired), or from 1,094 to 1,307 yards."

NOTE.—Vergnin obtained aniline red by causing the bichloride of anhydrous tin to re-act upon aniline. The red was very handsome, but he made very little of it. After awhile he employed other agents, which gave better results in respect to the amount of dye obtained; yet he did not obtain it in such a state of purity, or at so low a cost, as it is by Poirrier's process.—G.

"Arsenic acid was and is still employed almost exclusively; yet it leaves much to desire in respect even to amount of product obtained, for by the use of this acid there is more of the violet, the yellow, and the brown coloring-materials obtained, than there is of the reds. It is, moreover, a poisonous agent, whose use requires the greatest precautions, in order to avoid all accidents. Several attempts have been made to replace it with other agents, and, to a certain extent, with some success. No doubt, the time is not far distant when we shall arrive at results which will be entirely successful and satisfactory.

"At the commencement of the manufacture of aniline reds, small quantities at a time were operated upon (from eleven to twenty-two pounds of aniline). To-day, large quantities are treated in a single apparatus. Into a cast-iron retort of a capacity of about four hundred and forty gallons, they put—

1,100 lbs. of aniline,
1,650 lbs. of arsenic acid (75 per cent.).

"They apply heat, and constantly agitate the mass by means of paddles fixed in an iron shaft, which traverses the retort from axle to axle. Water and aniline are distilled and condensed in a worm, which is in communication with the retort. At the end of some hours the operation is finished. Completion is recognized when, on drawing out a portion or sample of the mass, they have a product, which, upon cooling, becomes hard, and whose fracture is brilliant. They then draw the fire, and cause a jet of boiling water to enter the retort.

The aniline attached is drawn off. The liquid mass is then conducted, by means of pipes, into an apparatus of great capacity, also provided with a number of agitators or mixers.

"The product, which is kept boiling for some hours in a large amount of water, becomes dissolved in it. They then add carbonate of lime, which takes up the arsenic acid, forming an insoluble salt. Then they let the contents of the vessels remain awhile undisturbed. The solid or resinous matters are deposited, and they filter the liquid into large vats. By cooling, the aniline red is deposited upon the walls of the vessel in the form of brilliant green crystals. There is nothing more to be done except to collect these crystals and dry them.

"The quantity of red thus obtained varies with the composition of the anliline set to work; that is to say, according as the aniline contains more or less aniline, toluidine, or pseudo-toluidine.

"We have said that aniline red was the salt of a colorless base, which is called rosaniline. For the transformations into blue, violet, green, &c., rosaniline is often used instead of the salts. We ought then to tell how it is prepared. To a boiling dilute solution of quite pure aniline red, it is only necessary to add the quantity of soda requisite to decompose the salt. Ebullition is maintained for some time, and, by cooling, is deposited a beautiful white crystalline powder, which is the rosaniline."

ANILINE BLUE (TRIPHENYLIC ROSANILINE, $C_{38}H_{31}Az_3H_2O$) — IMPERIAL VIOLET — SOLUBLE ANILINE BLUE.

"Aniline blue, discovered by Girard and De Laire, is a product in the form of a powder, of a bronze appearance, but sometimes of a deep blue color; it dissolves in alcohol, in wood spirits, and gives upon tissues very striking blues.

They color with this aniline, by using an acid, or else a mordant*; but without the use of these agents, a dull gray is obtained, or at the best a violet instead of a blue."

"Imperial violet, which is a product of the same nature as the blue, only less phenylated, acts as a dye in the same manner."

NOTE.—Nicholson found that the aniline blue would combine with sulphuric acid, the same as indigo would, and in consequence it became soluble in water; thus originated the soluble blue, so called.—G.

"The soluble blue is employed with success, especially by following a particular method of application, which gives good results, *dyeing in a neutral bath, and raising or heightening the color in an acid bath.*" (See Recipes for Blues.)

To obtain this blue, into an enamelled cast-iron retort, furnished with agitators, they put—

11 lbs. salt of rosaniline (or the acetate),
33 lbs. light aniline.

They heat the mass to 180°. It at first passes into violet, then into blue. They stop the operation, when, in drawing off a sample of the mass, they obtain in alcohol a solution of pure blue. The product is then turned into a vessel containing pure or diluted muriatic acid, which takes up the aniline that may be in excess; the blue precipitates. They then separate it by filtering, and washing it in boiling water; then they pulverize and dry it. If they wish blues of a very pure shade, they add to the ordinary handsome blue, some parts of alcohol. The reddish blue, being the most soluble, dissolves, while the green-blue remains, which they collect by filtration.

"Imperial violet is obtained exactly as the imperial blue is, only they stop the operation much sooner. They ascertain

* The best mordant we ever used (for fastness), was chrome, alum, and sulphate of soda, for wool, but for cotton-yarn, silicate of soda.—G.

the point where it is necessary to stop, by drawing off a sample from time to time, and dissolving it in alcohol.

"To render the blue soluble, they take one part of blue, and four to six parts of concentrated sulphuric acid. They heat the whole to a temperature which ought not to exceed 150°. They know that the blue is soluble, when, on drawing off a small sample, it dissolves in pure or slightly alkaline water. They then free it from excess of acid, by repeated washings in small quantities of water, and by the final addition of an alkali to neutralize it."

HOFFMANN VIOLETS.

MONOETHYLIC ROSANILINE ($C_{22}H_{23}Az_3H_2O$), RED SHADE.

DIETHYLIC ROSANILINE ($C_{24}H_{27}Az_3H_2O$), MEDIUM SHADE.

TRIETHYLIC ROSANILINE ($C_{26}H_{31}Az_3H_2O$), BLUE SHADE.

IODINE GREEN ($C_{25}H_{31}Az_3I_2H_2O$).*

"Hoffmann violet, which was discovered by the learned professor whose name it bears, differs from the imperial violet, in that the latter is a phenylic rosaniline, while the Hoffmann is a methylic or ethylic rosaniline; only, in substituting ethylic or methylic they never obtain blue, but a very blue-violet, and some green. Hoffmann violet, in its pure state, presents a brilliant green mass, which, excepting the iodhydrate contained in it, and soluble only in alcohol, dissolves in water into a brilliant green mass.

"They prepare it in a closed apparatus, or an arrangement for re-distillation. If they operate in a close vessel, they have an enamelled digester with a double bottom, which they heat by steam, or in an oil-bath.

* Hoffmann's and Charles Girard's.—G.

They put in—

5 kilogrammes rosaniline = 11 lbs. av.
26 " alcohol or wood spirits = 55 lbs. av.
12 to 15 " iodide of ethyl or of methyl = 24 or 30 lbs. av.

"They heat this mixture for three hours, to about 100°. If they have used iodide of methyl, green is formed at the same time as violet. They separate them by taking the mass previously freed from excess of iodides, and boiling it in a certain amount of water.

"When the liquor is cooled they filter it; the green is in solution, and the violet, which is in the form of iodhydrate, is precipitated; they separate by the addition of a small quantity of alkali; the little violet which might yet be in solution they filter again, and they precipitate the green by the addition of a solution of picric acid; the green is now in a flakey form. They collect this green upon a filter. The Hoffmann violet, freed thus from green, is treated by a lye of soda in a state of ebullition. The soda takes up the iodine, and forms iodide of sodium (which they afterwards decompose in order to recover the iodine), and they have the violet in the form of a colorless base. This base is treated with a quantity of muriatic acid necessary to form a neutral salt, and they have a product entirely soluble in water.

"If in place of the iodide of methyl, they use the iodide of ethyl, but little green is formed, and the whole mass is then treated according to the process already described for the Hoffmann violet, when it has been freed from the green formed by the use of the iodide of methyl."

Aldehyde Green.

"This green, as well as the iodide green, the Hoffmann violet, the blue, and the imperial violet, is obtained from aniline red. At first they transform the red into a peculiar blue, by the action of aldehyde. They take one part of aniline red,

dissolved in a mixture of two parts of sulphuric acid, and two parts of water. This mass becomes warm. When it has cooled they add, little by little, two parts of aldehyde, and leave it in contact with the rest. They draw, from time to time, small samples, which they dissolve in water; when they obtain a solution of pure blue, they turn the whole into about eighty-eight gallons of boiling water, which has in the solution two and one-fifth pounds of hyposulphite of soda. They stir the whole, then they filter it; the filtrated liquid contains the green. They use this filtered solution for coloring, or else they precipitate the coloring-matter in the form of paste, either with tannin or by the acetate of soda."

It is in the form of a paste that this green dye is generally sold.

COLORS DERIVED FROM COMPOUNDED ANILINES.

Paris Violet.

"The Paris violet is offered, like the Hoffmann violet, in the form of a green mass, brilliant, soluble in warm water, and even in cold water. They obtain with the Paris violet, as well as the Hoffmann violet, various shades, from the very reddest violet to the very bluest violet.

"They obtain the Paris violet by oxidizing a compounded aniline, containing the radical of an alcohol, or the radicals of different alcohols; they use generally methylaniline or dimethylaniline. The methylaniline easily becomes violet color." Here is one process, which gives good results:

Into an enamelled cast-iron digester, of the capacity of fifty-five gallons, placed in a wet bath, they put

50	kilogrammes	of methylaniline=110 lbs. av.
40	"	of chlorate of potash=88 lbs. av.
10	"	of iodine=22 lbs. av.

Chlorate of potash and iodine are added by degrees, for the space of some hours.

"When the first portion of iodine and chlorate has been put in, the mixture is heated to between 80° and 100°, and this temperature is kept up for four or five days, until they obtain a hard mass of a fine bronzed green. They treat this mass with a lye of soda; the chlorate in excess dissolves and the iodine combines with the soda. The violet, which is in the form of a base, is precipitated in a deep brown mass; they treat this mass with boiling water to take away the traces of iodide of sodium; then they take it up again with a certain amount of boiling water, which contains the necessary quantity of muriatic acid for forming a neutral salt with the base; they then have a bath strongly charged with violet; they filter it; the impurities remain upon the filter, and to the filtrated liquor is added some marine salt (common salt).

"The coloring-matter is precipitated, by cooling, in the form of a very brilliant, handsome green product. They pulverize and dry it, and it is sold in this condition."

Diphenylamine Blue.*

"This blue is obtained by causing sesquichloride of carbon to re-act upon a mixture of diphenylamine. Thus,—

1 part of the alkaloids,
½ to 1 part of the sesquichloride.

"They heat this mixture to between 160° and 180°; the mass is transformed into a bronzed product, which is purified by repeated washings in benzine and alcohol. This blue presents no characteristic distinction from those of the blues derived from rosaniline."

Aniline Black.

"Aniline black is produced upon tissues (cotton-yarn or fabrics), either by printing or by dyeing, but contrary to the

* This is a patent of Girard's and De Laire's.—G.

other aniline colors, it develops very well upon cotton, while up to the present time there have been no good results obtained by it upon wool or woolen fabrics."

"For obtaining the black in printing upon cotton, the following is the recipe laid down by Charles Lauth, and is generally practised to-day, that of Lightfoot having been abandoned, because the materials which he employed attacked the fibre and almost destroyed it.

10 litres farina starch,
350 grammes chocolate of potash,
300 " sulphuret of copper (in paste),
300 " sal-ammonia,
800 " chlorhydrate of aniline.

Or thus:

$2\frac{2}{10}$ gallons farina starch,
$11\frac{1}{3}$ ounces chlorate of potash,
$10\frac{3}{5}$ " sulphuret of copper (in paste),
$10\frac{3}{5}$ " sal-ammonia,
$28\frac{1}{5}$ " chlorhydrate of aniline.

"They print the yarn or fabric with this mixture, and carry into a very airy room; the black develops; then the yarn or cloth is washed either in pure or alkaline water.

"For coloring with the aniline black, the following is the method adopted, which was patented by Charles Lauth in 1872.

"The cotton (either yarn or cloth) is first mordanted in a concentrated solution of a salt of manganese; it is then dried; then passed through an alkaline bath; it is then exposed to the action of the atmosphere; then washed; then passed through the dye-bath which is made up as follows:

100 litres of water = 244 galls., nearly.
5 kilogrammes of aniline = 11 lbs., nearly.
10 " of chlorhydric acid = 22 lbs., nearly.

Or,—

22	gallons	of water,
11	lbs.	of aniline.
22	"	of chlorhydric acid.

NOTE.– When this article is taken out of the dyeing-bath it has a deep green color; it is then washed in an alkaline bath, which changes it into a magnificent black. After being washed, if the material is passed through a solution of bichlorate of potash, the color will be more intense.—G.

COLORS DERIVED FROM PHENIC ACID, NAPHTHALINE, AND ANTHRACENE.

"In the pure state, picric acid is sold in the form of crystals, in spangles of a clear yellow color; it dissolves in alcohol and in water.

"It is obtained by introducing, in small quantities at a time, nitric acid into phenic acid, or else into a mixture previously made with phenic and sulphuric acids.

"It is used in coloring yellows, and some particular shades of green, by mixture with a blue.* Picric acid, treated with the cyanide of potassium, is transformed into a peculiar acid called isopurpuric acid, whose color is red. The ammoniacal salt of this acid gives a coloring-matter analogous to murexide. The isopurpurates, in a dry state, detonate at the least shock."

It has of late become usual to employ, instead of pure picric acid, the soda-salt of this acid, under the name of aniline yellow. This has given rise to very serious accidents, owing to the highly explosive nature of this salt.

ROSALIC ACID—CORALLINE—AZULINE.

"Rosalic acid is obtained by treating a mixture of—

* See recipes for green on felt cloth.

One part oxalic acid.
One-half to one part phenic acid.
Two parts sulphuric acid.

Rosolic acid gives an orange-yellow color. When this acid is submitted to the action of ammonia, under pressure at a temperature of 150°, this product is transformed into a red coloring-material,* to which Guinon, Marnas, and Bonnett have given the name of coraline. These gentlemen obtained the blue coloring-material, which they have called azuline, by heating the red product (obtained with ammonia) with aniline."

Colors derived from Naphthaline.

"Many experiments have been made to obtain colors with naphthaline; but the only colors which have been prepared industrially, up to the present time, are a yellow and a red. The yellow† is obtained by the action of nitrate of soda upon the chlorhydate of naphthylamine; a liquor is obtained, which, heated to ebullition with nitric acid, gives small yellow needles, which separate and which they collect at the surface.

"The substance is analogous to picric acid, only it gives shades of a more golden yellow."

Naphthaline Scarlet.

"This substance was discovered by Schiendel, at Vienna (in 1867), and patented by Clavel of Basle. To obtain this scarlet they employ two alkaloids, — the naphthylamine and an oily product which is formed at the same time and which distils at a higher temperature. This last product has nitrate of protoxide of mercury added to it and is heated to a temperature not very high.

"There is formed a brown coloring-matter which they iso-

* This red will not resist the action of light.—G.

† By the Martius process, called Martius yellow.—G.

late from the mercury and from the tarry products that form at the same time. This brown matter is mixed wlth a certain amount of naphthylamine; they heat the whole, and the red forms; they free it of impurities by the means employed for the aniline colors.

"An analogous product is obtained after the method of Mons. Ulrich,* by causing nitrate of lead to re-act upon an acetate of rosaniline, then causing an alcoholic iodine to re-act upon the product thus obtained.

Artificial Alizarine.

"Graebe and Liebermann, to whom belong the honor of the discovery of artificial alizarine by means of anthracene, patented a process, which has since been perfected by Broenner and Gutzkow.

"These chemists treat anthracene by an oxidizing agent, such as the bichromate of potash, with sulphuric or some other acid, and, by preference, they take, as an oxidizing agent, nitric acid, twice the weight of the product. They obtain a substance, which they purify by sublimation, or by crystallization. Then they dissolve it in sulphuric acid by aid of heat, and then add a salt of mercury, a nitrate. The coloring-matter forms. They extract it by means of an alkaline bath, which develops the color. They filter. They precipitate by the addition of a small quantity of acid to the bath. Then they purify this coloring material by crystallization, or by sublimation. With this product they obtain the same shades as with the natural alizarine and purpurine, and the shades are all permanent colors."

"Once entered on the path, organic chemistry will not stop again, and we shall not despair of seeing indigo itself soon share the fate of madder, and be prepared by analogous processes."

* Mons. Ulrich obtained a patent for this method of obtaining red from naphthaline in 1868.—G.

NOTE.--The recent wonderful discovery of alizarine, or artificial madder, in coal-tar, has led practical men to expect *too much* from science. We know that the opinion is quite prevalent among manufacturers, that artificial indigotine has already been obtained from the same source. There are also some manufacturers who are sanguine that the difficulties of indigo-dyeing will thus be resolved. We do not think it improbable,—for what is impossible to modern chemistry?—that this result will yet be partially obtained. If the production of artificial indigotine should be realized, the only benefit would be the possible cheapening of indigo. The difficulties of the indigo-vat would still remain; for in the very difficulties of working an indigo-vat, or in the insolubility of blue indigotine by ordinary agents, consist the excellence of the dye.—G.

Of all the colors derived from tar, artificial alizarine will, no doubt, be the most important, both because of the large amount that will be consumed, but because of the revolution it will bring about in the agriculture of certain countries (the culture of madder).

Chemists sought for a long time to prepare it from naphthaline, because of the relations which exists in the composition of the two substances (alizarine and naphthaline), but it was Graebe and Liebermann, chemists of Berlin, who, applying to alizarine the process of reduction indicated by Mons. Berthellott, found that the hydro-carburet to which they went back, was anthracene, and not naphthaline. After this discovery, all that was wanting was to find a process by which they could transform the anthracene into alizarine. The above-named chemists were successful in finding a process of doing this; but later, Broenner and Gutzkow perfected the process of Graebe and Liebermann.

The anthracene is extracted from the solid product of coal-tar, by rectifying that product, but it is not yet known whether this product will be obtained in sufficient quantities to furnish the whole amount of alizarine which is given to-day by the madder.

The artificial alizarine has all the properties of the alizarine of madder; and over all the aniline colors, it has the advantage of producing permanent shades, although it has not their brilliancy.

IMPROVEMENTS AND DISCOVERIES MADE IN COAL-TAR COLORS.

From the first discovery of aniline violet by Dr. W. H. Perkins in 1856, to the present day, there is no art or science that has made, in the same number of years, such progression, and arrived at such a state of perfection, as that of producing artificial dyes from coal and its products.

To Poirrier and his co-laborers, more than to any other chemists, are dyers, and the world at large, mostly indebted for improvements, inventions and discoveries, which have been made towards the perfection of these colors.

The following compilation, as well as some of the preceding pages, are translated expressly for this work, from the reports of the Universal Exposition of Vienna in 1873.

" The house was first established in 1830. A. Poirrier has been at the head of the house since 1858, with Chappat, the younger, as partner, until 1868, since which time Porrier has been the sole proprietor of the house, having connected with him as co-laborers, such eminent chemists as Messrs. Charles Lauth, S. Morel, H. Baubigny, Luizet and others.

A. Poirrier has received the following medals and diplomas :

First, the medal of honor, London, 1862.

Gold medal, Paris, 1867.

Diploma of honor, Lyons, 1872.

Grand diploma of honor, Vienna, 1873.

At the Vienna Universal Exposition, in 1873, Charles Lauth received a diploma of honor ; Baubigny and Morel, medals of co-operation.

Charles Lauth also received a medal of the first-class from the Industrial Society of Mulhouse.

A platinum medal from the Society of Encouragement of Paris (for aniline black).

A gold medal, Paris, 1867.

A. Poirrier's chemists are thus classed and employed :

Charles Lauth, in general researches.

S. Morel, director of the factory for chemical products at Pecy.

H. Baubigny; researches, director of the manufacture of methyl-aniline violet and green.

T. Robatel; researches, director of the manufacture of rosaniline and its derivations.

Luizet, director of the manufacture of saffranine.

A. Poirrier is the sole proprietor of the patents for *violet de Paris*, and sole grantee of the right of working. He is also the proprietor of the patents of the Fuchsine Company of France; viz., those of Messrs. *Renard fréres et Franc*, for red; those of Messrs. *Girard et De Laire*, for blues; those of Mons. Hoffmann, for violet; those of Mr. E. C. Nicholson, for blue. His principal works are at St. Denis (Seine). There are employed in these works two hundred and fifty workmen; nine steam-motors, equal to seventy-five horse-power; eight generators, equal to three hundred and fifty horse-power. The branch establishment is at Pecy (Seine and Oise). These two, combined, are larger than any two aniline manufactories either in Europe or America.

The inventions and progress which A. Poirrier and his chemists have obtained and given to the public are,—

"First. The obtainment of violets from methylaniline, and from dimethylaniline, without iodine.

"Second. The transformation of these violets into blue violets, and very blue violets, replacing the iodides by a product more economical.

"Third. The substitution of methylaniline violets for rosaniline, for the manufacture of blue violets and night-green.

"Fourth. The obtaining of green from methylaniline without iodine, and application to industry of a product of the laboratory, and of a very advantageous method.

"Fifth. Industrial manufacture of this product.

"Sixth. New process of dyeing wool in night-green."

The results of these inventions and discoveries are—

"First. The entire suppression of the use of iodine in the manufacture of coloring-materials from coal-tar.

"Second. The advantages from the sanitary point of view of this suppression, and of the substitution of methylaniline violets for rosaniline.

"Third. Economy in the net price of violets and of greens, also improvement in the qualities."

INVENTIONS, PROGRESS.

I.—The Obtainment without Iodine of Methylaniline Violets.

"It is known that the discovery of ethylic and methylic derivatives of rosaniline, accomplished in a large part by the eminent Prof. Hoffmann, speedily brought about the depreciation and almost disappearance of other aniline violets.

"The manufacture of these new derivatives led to the discovery of night-green (called the iodine), which is formed at the same time as the violet, by the re-action of the alcoholic iodides of rosaniline, and whose importance has been increasing since then.

"The production of these beautiful coloring materials involves the consumption of considerable quantities of iodine. This substance, whose manufacture is very limited, was not slow to increase in value in a proportion truly extraordinary; for we saw it mount from the price (already very high for a raw material) of twenty francs to one hundred francs a kilogramme ($3.72 to $16.60 per $2\frac{1}{5}$ lbs. av.).

"The discovery of methylaniline violets constituted a great advance in their industry, and the rewards which the jury of 1867, at Lyons, accorded to A. Poirrier, show the importance which they attached to its discovery. But this was only a first step made in that direction, for although he was enabled to produce methylaniline without the use of iodine, he was

obliged to employ this last agent to transform the alkaloid into coloring-material. One of the processes patented by him, and which was still partially in operation at the factory at St. Denis at the time of the jury of 1867, depended upon the use of iodine.

"Mr. Charles Lauth has since obtained for him a new process, by which this use is wholly done away with, and which, without lessening the beauty of the product, increases the production of it.

"This process has been regularly in operation in their factory for more than eight years, and has enabled them to produce enormous quantities of the violet dye."

II.—Manufacture without Iodine, of Blue Violets.

"The discovery already mentioned was followed by other very important inventions. The consumption of violets is not limited to the use of a single shade; it requires a series of products, varying from the tint of the very red violet to the bluest violets. These blue-violets cannot be obtained directly by the oxidation of methylaniline, nor even by the oxidation of dimethylaniline. These blue shades can, to be sure, be obtained by causing the iodides of ethyl and of methyl to re-act upon the reddest violets; but in doing this you fall back upon the use of iodine, and thus lose a part of the advantage gained.

"In this state of affairs, recourse must be had to the use of chloride of benzyl, which has a remarkable action upon rosaniline, which Messrs. Lauth and Grimaux had previously pointed out. But instead of obtaining, as with rosaniline, a violet insoluble in water, they obtained, by the action of the chloride of benzyl upon the methylaniline violets, the manufacture of blue violets, soluble in water, and possessed of a brilliancy not attained by any of the products thus far known. These violets constitute new chemical substances, whose shade varies in accordance with the proportion of benzyl which they contain, and which has the property (much appreciated by

dyers) of fixing themselves upon animal fibre, with the presence of a certain amount of acid, and that without changing their brilliancy.

NOTE.—The addition of acid to the dye-bath gives to the wool a softer feeling, besides enabling the coloring matter to fix itself in a more even and uniform manner.—G.

"The introduction of the chloride of benzyl into the industry of artificial coloring-materials, obtains them at a relative low price, a fact which easily explains the value of this product, compared with that of the iodide of methyl (this last substance is now worth $18.60 per $2\frac{1}{5}$ lbs. av.), while the price of chloride of benzyl is about seventy-four and a half cents for the same number of pounds.

"So by this invention they have solved for the manufacture of violets from alcoholic radicals, this double problem of doing away with iodine, thus diminishing their net cost, and of improving their quality, by increasing their beauty and their tinctorial advantages."

III. — Substitution of Methylaniline Violet for Rosaniline for the Manufacture of Night-Green.

"The doing away with iodine in the manufacture of violets ought naturally to lead to the same progress in the manufacture of greens. We might even say that *there* was a more important point to attain, since the manufacture of greens consumes so much more important quantities of iodine; and this element, making a constituent part of green (as Messrs. Hoffmann and Girard have demonstrated), is absolutely lost, and goes out of circulation.

"The first advance realized in this line of ideas consisted in manufacturing *night-green* by the action of the iodine of methyl upon the methyl-aniline violets,* and no longer upon rosaniline. This last substance consumes more iodine, in

* Since the latter part of 1868, A. Poirrier has employed methylaniline violet exclusively for the manufacture of greens.—G.

order to be transformed into green, than does methylaniline violet, since the latter contains already a certain proportion of alcholic radicals, which is introduced in the case of the rosaniline, by the action of the iodides."

IV. — Manufacture, without Iodine, of Night-Green.

"When Poirrier and his chemists introduced into the manufacture of violets the use of chloride of benzyl, they were struck with the analogy which existed between this agent and the alcoholic iodides, and they made numerous efforts to substitute it for them in the manufacture of greens.

"The researches made in this direction, however, did not result in obtaining a green that was in any manner permanent, the green thus obtained being in very small quantities, and very insoluble. It therefore became necessary for them to search for some other product from which they could obtain a green dye.

Mons. Bauligny renewed the attempts which he had previously made, and had several times renewed before, and modifying them, succeeded in replacing the iodide of methyl with the nitrate of methyl, which, in the action exercised upon the methylaniline violet, effects the formation of a large amount of the green dye.*

"This process of manufacturing green has been carried on in Poirrier's factory since the end of the year 1871. This green appeared, in 1872, at the exposition of Lyons.

"No aniline manufacturer had, up to that time, offered night-green in that state of purity in which Poirrier presented it to the public. From that time the demand for consumption for such articles fastened more and more upon this particular shade of green, and the demand to-day is greater for this green than for any other shade.

* Comparison of the net prices of iodine of methyl, $18.60, and of nitrate of methyl, seventy-four and one-half cents per two and one-fifth pounds avoirdupois, shows the great advantage which results from the use of this last substance.—G.

NOTE.—The nitrate of methyl, by its action upon methylaniline, gives large quantities of green, but will give little or none in its re-action upon rosaniline.—G.

V.—MANUFACTURE OF THE NITRATE OF METHYL.

"The introduction into industry of an agent reputed so dangerous as the nitrate of methyl, was not made without difficulty. From 1866 they had been wishing to take up the manufacture of this article for the preparation of methylaniline. Their factory had been stopped, after some weeks of progress, by a series of accidents of every nature.

"The persevering efforts and skill of Mons. Morel triumphed over the difficulties inherent in the manufacture of this substance, and he has produced, up to this date (1873), over 44,000 pounds of nitrate of methyl without an accident. This is the same chemist who has had the direction of the manufacture of chloride of benzyl in Poirrier's works for the last eight years."

VI.—NEW PROCESS OF DYEING WOOL NIGHT-GREEN.

"The cheap production of night-green caused these chemists to search for the means of extending its applications.

"Although the silk and cotton dyers had succeeded without difficulty in using the green, it had not been so with the dyers of wool and woolen fabrics, on account of the woolen fibre not having the same affinity for the green dye as it has for the other aniline dyes or colors. Upon alkaline baths the dyes, in making the Nicholson blues, would give medium results only; it was therefore necessary to find a new and special process.

"Mons. Charles Lauth has accomplished this, by mordanting (or preparing) the wool with hyposulphite of soda." (The sulphur in the hyposulphite fixes itself within the fibre of the wool, which qualifies it to attract the green dye.)

"Shades of an incomparable intensity and beauty are thus obtained."

"Mons. Lauth made known, in 1869, a process of coloring

an aniline black on cotton by means of the peroxide of manganese. This process is based upon a principle analogous to that which has enabled the same chemist to render the discovery of aniline black useful in calico-printing." (Sulphide of copper.)

VII.—The Progress Effected in their Different Manufactures.

"Rosaniline and its derivations, blues, saffranine.

"The improvements which they have made in the manufacture of rosaniline and its derivations, are less important than those which they have just made known for obtaining violets and greens, but they are not less real.

"By making variations in the proportion of the different alkaloids which enter into its composition, the different sorts of rosaniline are obtained which are intended for the dye itself, or for this or that transformation.

"According to the particular shade of blue they wish to obtain, they cause the different and given alkaloids, in varying proportions, to re-act upon a determined variety of rosaniline.

"The blue, which is to be dissolved in alcohol, is not of the same composition as that which is to be dissolved in sulphuric acid.

"Finally, this manufacture of blue conjoined with sulphur is perfectly regulated, and there is obtained the first, the second, or the third acid combination, according to the applications to which these products are destined.

"All arrangements necessary in the way of preparations, instructions, and manipulations, are provided, in order to avoid any accidents which might result from the manufacturing of rosaniline.

"The manufacturing of rosaniline and of the blues, is under the direction of Mons. T. Robatel. The manufacturing of saffranine, which is a delicate process, is perfectly regulated under the directions of Mons. Luizet."

"In 1868 and 1869, the above-named chemists had produced, by original (with them) processes, a certain quantity of green, derived from benzyl-aniline and from dibenzyl-aniline, but on account of the amount of alcohol it required to dissolve this new coloring-material, and the cost resulting from the use of alcohol, and the inferiority in comparison to the methylic green (which is soluble in water), the manufacturing of this green was entirely abandoned."

RESULTS OF IMPROVEMENTS AND DISCOVERIES MADE BY POIRRIER AND HIS CHEMISTS.

I.—The Abandonment of Iodine in the Manufacturing of Coloring-Materials derived from Coal.

II.—The Advantages of this Abandonment from a Sanitary Point of View, and of the Substitution of Methylaniline Violets for that of Rosaniline.

"The production of iodine is one of the most limited. It is made only in France, upon the shores of Brittany, in Scotland, and in Ireland.

"The quantities produced by France and by Great Britain are very much of the same amount. This is one hundred and sixty-five thousand pounds for each country, making in all three hundred and thirty thousand pounds; but, in consequence of bad times in the last few years, this production has fallen to two hundred and twenty thousand pounds, for the consumption of the whole world.

"The manufacturing of violets and greens from alcoholic radicals made such a development, that the demand for iodine for that purpose was increased to one hundred and ten thousand pounds during the year 1871; and notwithstanding the war (in France), this amount represented one-half the total production.

"Moreover, the consumption of iodine for medicinal uses does not cease to increase.

"Iodine, in 1862, when it was employed only in pharmacy, was valued at $1.86 per pound, and reached, in 1872, the enormous price of $8.30 per pound.

"Such prices were a bait for fraud, and the adulterators applied themselves to giving to the bromide of potassium the appearance of the iodide, in order that it might be delivered to the trade as such. But, in consequence of the discoveries made by Mons. Lauth, the use of iodine in the manufacture of coloring-materials derived from coal is now entirely done away with; therefore iodine began to decline rapidly, and from the price of one hundred francs, in 1872, at which it was valued, it has declined to fifty francs now (1876), and there is no doubt but that it will have a further decline, and the fraud spoken of above will cease, the difference between the price of iodine and that of bromine being no longer great enough to tempt fraud.

"These new processes spoken of have not only contributed to exercise a happy influence, from a sanitary point of view, in restoring to pharmacy fifty thousand kilogrammes of iodine, but they contribute further to diminish, in a great proportion, the use of arsenic acid, a not less important advantage for health.

"In manufacturing by their processes the violets and the greens, without passing to them by way of rosaniline, diminish the consumption of rosaniline, which is always prepared with arsenic acid on account of the economy of the net cost.

"Now, for all the care and precaution we may take, the handling of large quantities of arsenic acid is very dangerous; therefore, the less use we make of it in making materials for colors, the less danger there will be encountered.

"From this they believe that they have rendered a great service to hygiene, as well as to the public health, by diminishing in a very great measure the use of rosaniline, in consequence of the arsenic acid it contains."

II. — Cheapness, Improvement of Qualities, and Extension given to the French Industry of Colors derived from Coal.

"By these discoveries they have been able to reduce the price of their violets and greens amazingly. Such grades of methylamine violets as they sold in 1867 at from one hundred and twenty to one hundred and forty francs per kilogramme ($2\frac{1}{5}$ lbs.), (while methylic, or ethylic violets, made from rosaniline, were selling at two hundred francs for the same number of pounds), are now sold by them for forty to fifty francs per two and a half pounds (or one kilogramme), and the quality is far superior. So they can say that, up to the present date, by the quality of their violets and greens, by their cheapness, and by their new processes of application, they have rendered the dyeing of the entire world tributary to France.

"The sum total of their sales has risen, by reason of the diminution of their prices; when, in 1867, the lowest price for violets was one hundred and twenty francs per kilogramme ($2\frac{1}{5}$ lbs.), the sales amounted to six hundred thousand francs; and in 1872 the sales reached the enormous amount of one million eight hundred thousand francs, when the price had fallen one-half (sixty francs). For their greens they have likewise seen their sales triple; from three hundred and fifty thousand francs, the figure which it had reached in 1870, their sales rose, in 1872, to nearly one million francs."

"The quality and cheapness of Poirrier's violets and greens have established a monopoly much more real and lasting than patents, which are so little respected and always so much debated."

"SAVOGRAN."

A WOOL AND WOOLEN FABRIC

SCOURING COMPOUND.

Wool washing and cleaning is a very important item in the manufacture of Woolen Goods, and any improvement, or suggestion, will claim the attention of all in the business. It is not only important that the Wool should be clean, but that it should be left in as natural a state as possible. The manner in which Wool is often delivered to the carder, although clean, is harsh and brittle, thereby causing loss in waste by carding as well as in weight in manufacturing, and preventing the colors from taking so clear or bright as when the Wool is soft and white.

Soda Ash has invariably been found too harsh in its nature; and when, as is often the case, the washer finds a stubborn Wool to clean, he uses an excess of Ash, thereby destroying the elasticity of the fibre, and causing a loss by electricity in spinning the yarn.

Among the many inquiries we have as to what we shall use in place of Ash, we would say that many of the large Woolen Mills are using

"SAVOGRAN,"

Manufactured by Messrs. MASURY, YOUNG & CO., of Boston, and, in using it for the past three or four years, have found that it overcomes the objection to Soda Ash. We call the attention of those interested to the advertisement on page opposite, in regard to its use, &c.

Part Fourth.

TABLE OF PRIME EQUIVALENTS OF CHEMICAL SALTS AND DYESTUFFS;

GLOSSARY OF TECHNICAL TERMS AND CHEMICAL NAMES;

COLORED SAMPLES, WITH RECIPES.

TABLES.

A French Table of Prime Proportions between Bichromate of Potash and the Different Dyewoods, with the Colors produced.

[We insert this without comment, leaving it to the dyer to form his own conclusions as to its correctness, &c.]

Bichromate of Potash, lbs.	Logwood, lbs.	Fustic, lbs.	Hypernic, lbs.	Color Produced.
$2\frac{1}{2}$	30–40	–	–	Black.
$1\frac{3}{4}$	18–22	–	–	Slate.
$1\frac{1}{4}$	12–15	–	–	Lead.
$\frac{3}{4}$	3–6	–	–	Gray.
$2\frac{1}{2}$	26	4	–	Invisible-green,
$2\frac{1}{2}$	24	12	–	Green.
$2\frac{1}{2}$	18	38	–	Dragon-green.
$2\frac{1}{2}$	15	25	–	Bottle-green.
$2\frac{1}{2}$	18	14	–	Swallow-green.
$2\frac{1}{2}$	8	70	8	Myrtle-green.
$2\frac{1}{2}$	12	6	10	Dark-olive.

Bichromate of Potash—time for boiling, one and a quarter hours.

Logwood, Fustic, and Hypernic, time for boiling, three-quarters of an hour.

A Table of Equivalents or Proportions of Chemical Salts and Rough Dyestuffs used to Produce Colors by the Stuffing and Saddening Process. (See Processes for Dyeing.)

[This table is for one hundred pounds of scoured or clean wool. Water used, five hundred gallons.]

NAMES OF DYESTUFFS TO BE USED.								NAMES OF CHEMICAL SALTS USED TO SADDEN OR FASTEN THE COLOR.			
Logwood, lbs.	Fustic, lbs.	Camwood, lbs.	Madder, lbs.	Barwood, lbs.	Hypernic, lbs.	Sanders, lbs.	Sumac, lbs.	Copperas, lbs.	Alum, lbs.	Blue Vitriol, lbs.	Color produced.
35	5	–	2	–	–	–	–	5	–	–	Black.
30	–	3	–	–	–	–	–	–	1	1	Blue-black.
–	24	–	–	–	–	10	8	–	–	–	Bronze.
2	2	30	7	–	–	7	–	2	–	1	Red-brown.
–	25	25	12	–	–	–	–	2	–	1	Coffee-brown.
10	–	20	5	–	30	–	–	2	3	–	Maroon.
10	50	–	10	–	–	–	–	2½	–	–	Olive.
10	–	65	–	–	–	–	–	1	–	5	Claret.

We might continue these tables of prime equivalents or proportions much further, but this must suffice for the present, leaving it for the more skilful and scientific dyer to investigate and carry out.

A Table of Equivalents or Proportions of Chemical Salts and Rough Dyestuffs used to Produce Colors.

[This table is calculated for one hundred pounds of scoured or clean wool, of a medium quality. Water to be used, five hundred gallons.]

Names of the Salts for the Preparation of the Wool.							Names of Dyestuffs Used in the Finishing of the Color on the Wool.								
Chrome, lbs.	Blue Vitriol, lbs.	Alum, lbs.	Tartar, lbs.	Oxalic acid, lbs.	Tin Crystals, lbs.	Sulphate of Soda, lbs.	Cudbear, lbs.	Barwood, lbs.	Red Sanders, lbs.	Hypernic Wood, lbs.	Camwood, lbs.	Madder, lbs.	Fustic, lbs.	Logwood, lbs.	Color produced.
2	–	–	2	½	–	–	–	–	8	–	20	14	45	3	Full brown.
1½	–	12	3	–	–	–	–	–	–	60	10	–	10	6	Cherry-brown.
2½	1¼	–	2	–	–	–	–	–	5	–	10	14	60	1	Brown.
3	2	1	–	–	–	–	–	–	–	–	–	–	5	40	Black.
2½	3½	–	2½	–	–	–	–	–	–	–	–	–	8	45	Jet black.
–	–	15	–	–	–	5	–	40	–	12	–	–	15	3	Maroon.
3	–	1½	–	–	2	–	–	–	–	5	–	–	–	40	Blue-black.
3	–	–	3	–	–	–	–	–	–	–	5	8	45	10	Olive.
1½	–	3	1½	–	–	–	–	–	–	–	–	–	–	24	Blue.
1	–	3¼	1¼	2¼	–	–	½	–	–	–	–	–	–	40	Another blue.

GLOSSARY

OF

TECHNICAL TERMS AND CHEMICAL NAMES

USED IN THIS WORK.

Aqua fortis, nitric acid.

Alterant, a substance added to a color to give it brightness, "raising."

Argol, bitartrate of potash, formed by deposit in wine-casks.

Aqua regia, a mixture of muriatic and nitric acids, two parts of the former and one of the latter.

Alkalies (*fixed*), soda, pot, and pearlash.

" (*volatile*), ammonia.

" (*compounds*), urine and soap.

Ammonia, see article, ammonia.

Azote, nitrogen.

Aqueous tincture, watery solution of any substance.

Acidulous salts, all salts that contain an acid.

Alumina, a clay that will combine with acids, forming salts, such as alum.

Acetate of copper, verdigris, a mixture of acetate of lead and copper, or blue vitriol.

Acetic acid (*vinegar*), see article, acetic acid.

Acidulated, a solution containing acid.

Acid bath, a solution containing acid.

Acetate of iron, a solution of copperas and acetate of lead.

Acetate of lead, sugar of lead, a combination of lead and acetic acid.

Acetate of chrome, a combination of chrome, oil of vitriol, and sugar of lead.

Acetate of alumina, a combination of four parts sugar of lead, five parts alum, and eleven parts water.

Aeriform, having the form or appearance of air.

Astringents, a general term for such dyestuffs as contain the astringent principle, or are possessed of the property of tannin, such as sumac, oak bark, cutch, &c.

Alkaline solutions, lime, or potash water.

Bisulphate of copper, blue vitriol, blue stone.

Bichromate of potash, red chromate of potassa, chrome.

Bois rouge, camwood.

Borate of soda, borax.

Bichloride of tin, double muriate of tin.

Barilla, the name of an impure soda imported from Spain and the Levant.

Bisulphuret of iron, iron pyrites.

Binoxalate of potash, salt of sorrel, or oxalic acid.

Boracic acid, boron combined with oxygen.

Braziline, the solid extract of hypernic, peachwood, &c.

Bitartrate of potash, or potassa, cream of or refined tartar.

Bichloride of mercury, corrosive sublimate.

Bisulphate of soda, a combination of soda and oil of vitriol.

Bisulphate of potash, a combination of potash and oil of vitriol.

Bromine, one of the elements. See Table of Elements.

Bisulphate of iron, a very poor kind of copperas.

Benzole, or benzine, a product derived from coal-tar.

Bottom, or bottoming, to put part of the color upon the wool or cloth, by immersing it in the blue vat.

Calcium, lime.

Crystals of tin, salts of tin, or muriate of tin crystals.

Carbonate of soda, crystallized soda.

Carbonate of lime, whiting.

Chloride of calcium, lime and muriate of soda (salt).

Chloride of tin, muriate of tin, muriatic acid, killed with tin.

Citric acid, lemon-juice.

Chemical salts, acids uniting to any of the earthy, alkaline, or metallic bases.

Color, a term used synonymously to express the coloring liquor, the color on the fabric, or the composition of the color.

Carmine, coloring-matter of cochineal, extracted and dried.

Caustic lye, the clear liquor from a solution of soda-ash and lime.

Citrate of lime, lime in combination with citric acid.

Cupric sulphate, blue vitriol.

Chloride of potassium, combination of magnesia, muriatic acid, and mineral salts.

Crystallized verdigris, acetate of copper.

Chloride of potash, the clear liquor of bleaching powder and pearlash.

Caustic soda-lye, see caustic lye.

Chloride of calcium, lime through which chlorine has passed.

Copperas, protosulphate of iron.

Chlorine, a gas obtained from oxygen and muriatic acid.

Chloride of copper, a combination of oxide of copper and muriatic acid.

Chromate of potash, yellow chromate of potash combined with caustic potash.

Chlorate of potash, chlorine gas combined with carbonate of potash.

Cyanide of potassium, red prussiate of potash and carbonate of potash combined.

Chromate of lead, chrome and acetate of lead combined in solution.

Chromic acid, a combination of chrome, chrome iron ore, and oil of vitriol—dark crimson color.

Caustic lime, slacked lime.

Chloride of sodium, common salt.

Chemic, sulphate of indigo (which see).

Carbonic acid, a combination of marble or chalk, with diluted muriatic acid.

Calcareous water, water impregnated with lime or other alkalies.

Couching, the curing or preparing of woad for the blue-vat.

Caloric, the principle or matter of heat.

Calorific, producing heat.

Curcumine, a plant named *Curcuma langa;* from the roots we obtain turmeric.

Carbolic acid, an acid obtained from coal-oil.

Catalysic, an affinity or power; a chemical change among the particles of bodies, one body inducing a chemical change in another.

Carbonate of ammonia, the products of distillation of bones, or a mixture of chalk and sal-ammoniac sublimed.

Caseine, curd of milk.

Calcareous, having the properties of lime.

Doctored, to adulterate; generally applied to such dyestuffs as are not good.

Dip, generally applied to immersing wool or cloth in the blue-vat or dye-tub.

Double muriate of tin, bichloride of tin (which see).

Dilute, or diluted, to weaken or reduce with water, as diluted oil of vitriol.

Decoction, a watery solution of any coloring-matter or material.

Extract of fustic, the solid coloring-matter of fustic.

Extract of logwood, the solid coloring-matter of logwood.

Extract of indigo, an erroneous term applied to *sulphate of indigo*, or chemic.

Epsom salts, sulphate of magnesia.

Extractor, a machine for depriving the wool, cotton, or cloth of its superfluous water or coloring solution.

Essential salt of lemons, see binoxalate of potash.

An extract, the solid coloring-matter of the different dye-woods, such as logwood, fustic, and quercitron.

Flurry, or fluery of a blue-vat, the froth of oxidized indigo floating on the vat.

Feathering, to granulate a metal, to feather tin to kill the different acids.

Fast color, a permanent color.

French tub, muriate of tin and logwood, called plumb-tub.

Formula, the manner or form in which the recipes are written; the recipe or its form.

Ferrocyanide of potassium, yellow prussiate of potash.

Ferricyanide of potassium, red prussiate of potash.

Glauber salts, sulphate of soda.

Green vitriol, copperas.

Grain tin, metallic tin.

Garancine, one of the coloring products of madder.

Gypsum, sulphate of lime.

Gallic acid, an acid obtained from nutgalls.

Glycerine, a sweetish oil obtained from fat.

Hematine, extract of logwood.

Hematoxylon campechicum, logwood.

Hydrochloric acid, muriatic acid.

Hartshorn, the volatile alkali, ammonia.

Hyponitric acid, peroxide of nitrogen.

Hydrochlorate of rosaniline, fuchsine or magenta.

Hydrate of lime, lime dry-slacked, termed *ware* in blue-dyeing.

Hypochlorite of lime, bleaching powders.

Indigo paste, the soda sulphate of indigo.

Iodide of potassium, iodine and potash.

Isomeric, properties which give the same number and weight of elements, signifying equal parts.

Iron liquor, nitric acid killed with iron.

Killing, dissolving tin or iron in muriatic or nitric acids.

Kilo, or kilogramme, a French weight equal to 2 pounds, 8 ounces, 1 drachm, and 14 grains.

Lactine, a curd of milk used for animalizing cotton, sometimes called *lactarine*.

Lye, solution of an alkali, as potash or soda.

Limestone, carbonate of lime.

Litharge, protoxide of lead.

Logwood liquor, a thick, syrupy solution of the coloring-matter of logwood.

Lactic acid, an acid contained in milk.

Litharge, protoxide of lead. (See protoxide of lead.)

Litre, a French measure containing a fraction over a quart.

Mordant, any one, or a mixture, of several chemical salts used in dyeing, is the mordant or base of the color, and can be applied before, or at the same time, or after the coloring matter has been boiled on; in the latter case it is called *saddening*. In cotton dyeing it is generally applied to the acetate of alumina.

Mineral alkali, soda.

Muriatic acid, hydrochloric acid.

Marine acid, hydrochloric acid.

Muriates, chlorides.

Muriate of soda, common salt.

Muriate of sodium, common salt.

Muriate of tin, muriatic acid, killed with tin.

Murio-sulphate of tin, muriatic and sulphuric acids, killed with tin.

Murio-nitrate of tin, a mixture of muriatic and nitric acids, killed with tin, the muriatic acid being in excess; the same with the murio-sulphate.

Muriate of iron, muriatic acid, killed with iron.

Maclurine acid, an acid contained in fustic.

Muriate of ammonia, sal-ammoniac.

Morine, the pure coloring principle of fustic.

Morus tinctoria, fustic.

Nitro-muriate of tin, nitric and muriatic acids, killed with tin, the nitric being in excess.

Nitrate of iron, nitric acid killed with iron, iron liquor.

Nitrate of copper, copper, killed with nitric acid.

Nitrate of soda, nitric acid added to common soda.

Nitric acid, an acid obtained by distilling nitrate of potash and oil of vitriol together.

Nitrate of potash, saltpetre.

Nitrate of lead, metallic lead, dissolved in nitric acid.

Nitro-muriatic acid, see aqua regia.

Nitrate of zinc, a solution of nitric acid and zinc.

Nitrate of alumina, a solution of alum, soda crystals and nitrate of lead.

Oxymuriate of potash, see chlorate of potash.

Oxymuriatic acid, chlorine.

Oil of vitriol, sulphuric acid.

Oxymuriate of tin, perchloride of tin, or tin dissolved in nitric and muriatic acids, sometimes called permuriate of tin.

Oxalate of copper, oxide of copper digested in oxalic acid.

Oxalate of potash, crystallized carbonate of potash and oxalic acid.

Oxalate of potassa, see oxalate of potash.

Orcine, or orceine, the pure coloring matter of archil.

Pearlash, carbonate of potash.

Permuriate of tin, see oxymuriate of tin.

Prussiate of potash, see ferrocyanide of potassa, or potash.

Potash sulphate of alumina, alum.

Protosulphate of iron, copperas.

Phenic acid (*carbolic acid*), an acid found in coal-tar.

Persalt of mercury, red oxide of mercury, dissolved in oil of vitriol.

Protoxide of tin, a precipitate formed from a solution of crystals of tin by carbonate of soda.

Peroxide of tin, the ores of tin, *tinstone*.

Potash, a strong caustic alkali.

Pyrolignate of iron, a brown liquid solution of iron in pyroligneous acid, improperly termed iron liquor.

Pyroligneous acid, an acid obtained from wood, by the process of destructive distillation.

Protoxide of lead, lead and oxygen combined in equal parts.

Protochloride of tin, see oxymuriate of tin.

Perchloride of tin, tin dissolved in nitric and muriatic acids, generally called nitro-muriate of tin.

Pigment, a coloring substance, as paints.

Potassa, an alkaline salt obtained from different ashes,—ashes from plants, &c.

Potassium, a white, soft metal with a lustre like silver.

Phenic acid, see carbolic acid.

Pyrogallic acid, an acid obtained by heating gallic acid to 420°.

Persulphate of iron, a solution of copperas, and sulphuric and nitric acids.

Precipitate, a substance in solution chemically separated from its solvent and thrown to the bottom of the vessel.

Pyrites, a combination of sulphur with iron, copper, cobalt or nickel.

Protosalts of iron, sulphate of iron.

Picric acid, an acid obtained from carbolic acid.

Red tartar, crude cream of tartar, argols.

Raising, see alterant.

Red liquor, acetate of alumina.

Rosalic acid, an acid from coal-tar.

Ruberythimic acid, an acid obtained from madder.

Re-agents, different substances acting upon other substances.

Radical salts, any element or compound that forms an acid when combined with hydrogen, and a salt when united with a metal. Sulphuric and nitric acids are radical salts.

Sulphate of iron, copperas.

Supertartrate of potash, cream of tartar.

Sulphomuriate of tin, sulphuric and muriatic acids killed with tin. (See solutions of tin.)

Sulphate of indigo, chemic, indigo paste, extract of indigo. (See article, Sulphate of Indigo.)

Sulphuric acid, oil of vitriol.

Soda-ash, a crude caustic alkali or carbonate of soda.

Santaline, the pure coloring-matter of red sanders.

Sal-soda, crystallized carbonate of soda.

Soda crystals, crystallized carbonate of soda.

Sadden or saddening, giving the mordant after the coloring-matter is boiled on the wool or goods; making a color darker by means of a chemical salt, such as copperas, blue vitriol, alum, &c.

Sulphate of magnesia, epsom salts.

Sal-ammoniac, hydrochlorate of ammonia, crystallized ammonia.

Sulphate of lime, a substance formed of carbonic acid and lime, nearly insoluble. It is found in small quantities in spring waters.

Sulphate of soda, glauber salts.

Sulphate of copper, blue vitriol.

Spirits, the different solutions of tin.

Spirits of salt (erroneously called so), muriatic acid.

Sp. gr., specific gravity, or density.

Salinixon, see bisulphate of potash.

Sal-volatile, sesquicarbonate of ammonia.

Salts of lemon, citric acid.

Saltpetre, nitrate of potash.

Salts of tin, crystallized protochloride of tin.

Slacked lime, hydrate of lime.

Spirits of wine, alcohol.

Sugar of lead, brown and white acetate of lead.

Substantive color, a color fixed in the fibre without base or compound.

Salts of alumina, alum, acetate of alumina, &c.

Sulphate of lime, gypsum.

Sodium, one of the elements.

Subacetate of lead, a combination of sugar of lead and litharge.

Sesquioxide of iron, a combination of carbonate of soda and iron.

Salifiable bases, bases capable of becoming a salt.

Storax, a juice obtained from the bark of the fir-tree.

Sulphuret of copper, a solution of blue vitriol, caustic soda, and sulphur.

Sulphate of alumina, alum.

Salts, or chemical salts, acids united to any of the earthy, alkaline, or metallic bases.

[The salts employed as mordants in dyeing are of two kinds,—the simple and compound. The simple is some substance that assumes a crystalline as its common shape, such as oxalic, tartaric, and citric acids. The compounds are composed of two or more substances in chemical union, such as sulphate of copper, alumina, and iron. The term salt, in the strictest sense, seems to apply almost exclusively to the latter class. In cotton-dyeing, mordant is only applied to acetate of alumina.]

Tannin, the astringent principle contained in many substances used in dyeing, and other purposes. It is that property contained in barks, &c., which converts raw hides into leather, called tanning. It is the same principle, under another name, as the astringent principle.

Tannic acid, obtained by digesting nutgalls in ether.

[When it is pure it is a solid, uncrystallizable, white or slightly yellowish in color; it is inodorous, very astringent to the taste, but not bitter.]

Tincture of soap, soap dissolved in alcohol.

Vegetable alkali, potash.

Verdigris, acetate of copper.

Volatile alkali, ammonia.

White vitriol, sulphate of zinc.

White copperas, sulphate of zinc.

Ware, hydrate of lime, slacked lime.

TABLE OF SYMBOLS AND FORMULAS.

	Old Notation.	New Notation.
Acids.		
Acetic,	$C_4H_4O_4$	$C_2H_4O_2$
Arsenic,	AsO_5	H_3AsO_4
Arsenious,	AsO_3	H_3AsO_3
Benzoic,	$C_{14}H_6O_4$	$C_7H_6O_2$
Boracic,	BO_3	H_3BO_3
Carbonic,	CO_2	No change.
Carbolic,	$C_{12}H_6O_2$	C_6H_6O
Carminic,	$C_{18}H_8O_{10}$	$C_9H_8O_5$
Catechutannic,	$C_{30}H_{14}O_{12}$	$C_{15}H_{14}O_6$
Chromic,	CrO_3	No change.
Citric,	$C_{12}H_8O_{14}$	$C_6H_8O_7$
Cresylic,	$C_{14}H_8O_2$	C_7H_8O
Gallic,	$C_{14}H_6O_{10}$	$C_7H_6O_5$
Hyponitrics,	NO_4	N_2O_4
Lactic,	$C_{12}H_{12}O_{12}$	$C_3H_6O_3$
Morintannic,	$C_{26}H_{10}O_{12}$	$C_{13}H_{10}O_6$
Muriatic,	HCl	No change.
Nitric, anhydrous,	NO_5	N_2O_5
Nitric,	HO,NO_5	HNO_3
Nitrius,	NO_3	HNO_2
Nitro-muriatic,	NO_2Cl_2	$2H_2O+NOCl+Cl_2$
Oxalic,	$C_2H_3O_{16}$	$C_2H_6O_6$
Phthalic,	$C_{16}H_6O_8$	$C_8H_6O_4$
Pyrogallic,	$C_{12}H_6O_6$	$C_6H_6O_3$
Rosolic,	$C_{40}H_{16}O_4$	$C_{20}H_{16}O_2$
Ruberythic,	$C_{40}H_{22}O_{22}$	$C_{20}H_{22}O_{11}$
Sulphuric,	$HOSO_3$	H_2SO_4
" Nordhausen,	HO,SO_3+SO_3	$H_2S_2O_7$
Tannic (galls),	$C_{54}H_{22}O_{34}$	$C_{27}H_{22}O_{17}$
Tartaric,	$C_8H_6O_{12}$	$C_4H_6O_6$
Chemical Compounds.		
Aluminium,	Al	No change.
" acetate of,	$Al_2O_33(C_4H_3O_3)$	–
" chloride of,	Al_2Cl_3	Al_2Cl_6
" nitrate of,	$Al_2O_33NO_5$	$Al3NO_3$
" sulphate of,	$Al_2O_33SO_3$	Al_23SO_4
Alum, ammonia,	$\left\{ \begin{array}{l} Al_2O_33SO_3NH_4OS \\ O_3+24HO \end{array} \right\}$	$Al_2(NH_4)_24SO_4+24H_2O$
" chrome,	$\left\{ \begin{array}{l} Cr_2O_33SO_3KO,S \\ O_3+24HO \end{array} \right\}$	$KCr2SO_4+12H_2O$
" potash,	$\left\{ \begin{array}{l} Al_2O_33SO_3,KOS \\ O_3+24HO \end{array} \right\}$	$Al_2K_24SO_4+24H_2O$

Table of Symbols and Formulas—Con.

	Old Notation.	New Notation.
Ammonia gas, . . .	NH_3	No change.
“ aqua, . .	NH_4O	NH_4HO
“ carbonate of, .	NH_4OCO_2	$(NH_4)_2CO_3$
“ chloride or muriate of, .	NH_4Cl	No change.
“ nitrate of, .	NH_4O,NO_5	NH_4NO_3
“ sulphide of, .	NH_4S	$(NH_4)_2S$
“ sulphate of, .	NH_4O,NO_5	NH_4NO_3
Antimony, teroxide of, .	SbO_3	Sb_2O_3
Borax, ...	$NaO2BO_3$	$Na_2B_4O_7$
Barium, ...	Ba	Ba
“ acetate of, . .	$C_4H_3BaO_4$	$C_2N_3O_2Ba$
“ chloride of, .	BaCl	$BaCl_2$
“ sulphate of, .	$BaOSO_3$	$BaSO_4$
Chromium, ...	Cr	No change.
“ acetate of, .	$C_{12}H_9Cr_2O_{12}$	$Cr_22(C_2H_3O_2)$
“ chloride of, .	Cr_2Cl_3	Cr_2Cl_6
“ sesquioxide of,	Cr_2O_3	No change.
“ teroxide of, .	CrO_3	“
Copper, ...	Cu	“
“ chloride of, . .	2CuCl	$CuCl_2$
“ nitrate of, . .	$CuONO_5$	$Cu2NO_36H_2O$
“ black oxide of, .	CuO	No change.
“ red oxide of, .	Cu_2O—	“
“ oxalate of, . .	$Cu_2C_4O_8$	$2C_2Cu_{11}O_4,H_2O$
“ sulphide of, . .	CuS	CuS
“ sulphate of, . .	$CuOSO_3+5HO$	$CuSO_4+5H_2O$
Iron, bisulphide of, . .	FeS_2	No change.
“ ferrous oxide of, .	FeO	“
“ hydrated ferrous oxide of, . . .	FeO,HO	FeH_2O_2
“ ferric chloride of, .	Fe_2CC_3	Fe_2Cl_6
“ oxalate of, . .	–	–
“ sesquioxide of, .	Fe_2O_3	No change.
“ sulphide of, . .	FeS	FeS
“ sulphate of, . .	FeO,SO_3+7HO	$FeSO_4+7H_2O$
“ persulphate of, .	$Fe_2O_33SO_3$	Fe_23SO_4
Lead, ...	Pb	No change.
“ acetate of, . .	$PbO_4C_4H_3+3Ay$	$Pb2C_2H_3O_2,3H_2O$
“ basic acetate of, .	$C_4H_3O_33PbO$	$2PbOPb2C_2H_3O_2$
“ carbonate of, . .	PbO,CO_2	$PbCO_3$
“ chloride of, . .	PbCl	$PbCl_2$
“ red chromate of, .	$2PbOCrO_3$	Pb_2CrO_5
“ yellow chromate of,	$PbOCrO_3$	$PbCrO_3$
“ nitrate of, . .	$PbONO_5$	$Pb2NO_3$
“ protoxide of, . .	PbO	No change.
“ sulphate of, . .	$PbOSO_3$	$PbSO_4$

Table of Symbols and Formulas—Con.

	Old Notation.	New Notation.
Lime (calcium), . .	Ca	No change.
" acetate of, . .	$CaO_4C_4H_3$	$Ca(C_2H_3O_2)_2$
" chloride of, . .	$CaCl$	$CaCl_2$
" bleaching powders,	$CaO,ClO+CaCl$	$CaCl_2Ca2ClO$
" caustic, . . .	CaO	CaO_2
" carbonate of, . .	$CaOCO_2$	$CaCO_3$
" oxalate of, . .	CaO,C_2O_3	CaC_2O_4
" phosphate of, . .	$3CaOPb_5$	Ca_32Pb_4
" sulphate of, . .	$CaOSO_3$	$CaSO_4$
" slack, . . .	$CaOHO$	CaH_2O
Mercury, ...	Hg	Hg
" nitrate of, .	$HgONO_5$	HgN_2O_6
" protoxide of, .	-	-
Magnesium, ...	Mg	No change.
" sulphate of, .	$MgOSO_3+7HO$	$MgSO_4+7H_2O$
Potassium, . . .	K	No change.
" anhydrous, . .	KO	K_2O
" bicarbonate of, .	$KO2CO_2$	$HKCO_3$
" bichromate of, .	$KO2CrO_3$	K_22CrO_4
" binoxalate of, .	$KO2CrO_3$	-
" bisulphate of, .	$KO2SO_3$	$HKSO_4$
" carbonate of, .	$KOCO_2$	K_2CO_3
" caustic of, . .	$KOHO$	KHO
" chlorate of, . .	$KOClO_5$	$KClO_3$
" chloride of, . .	KCl	No change.
" chromate of, .	$KOCrO_3$	K_2CrO_4
" cyanide of, . .	KCy	KCy
" ferricyanide of, .	$K_3Cy_6Fe_2$	$K_3F_2Cy_6$
" ferrocyanide of, .	K_2Cy_3Fe	K_4FeCy_6
" iodide of, . .	KI	KI
" oxalate of, . .	KOC_2O_3	-
" permanganate of,	$KOMn_2O_7$	$KMnO_4$
" sulphate of, . .	$KOSO_3$	K_2SO_4
" sulphide of, . .	KS	K_2S
" tartrate of, . .	$KO,HOC_8H_4O_{10}$	$HKC_4H_4O_6$
" tartar emetic of, .	$KOSb_2O_3C_8H_4O_{10}$	$2(KSbOC_4H_4O_6)Ay$
Silver, ...	Ag	No change,
" nitrate of, . .	$AgONO_5$	$AgNO_3$
Sodium, ...	Na	No change.
" acetate of, . .	$NaOC_4H_3O_3+6HO$	$C_2H_3O_2Na$
" bicarbonate of, .	$NaO2CO_2$	$HNaCO_3$
" bisulphate of, . .	$NaO2SO_3$	$HNaSO_4$
" carbonate of, . .	$NaOCO_2$	Na_2CO_3
" carbonate of (crystallized), . .	$NaOCO_2+10HO$	$Na_2CO_3+10H_2O$
" caustic, . . .	$HONaO$	$HNaO$
" chloride of, . .	$NaCl$	NaC

Table of Symbols and Formulas—Con.

	Old Notation.	New Notation.
Sodium,		
" glauber salts of, .	$NaOSO_3+10HO$	$Na_2SO_4 10H_2O$
" hydro-sulphite of, .	$NaOS_2O_2$	Na_2SO_2
" nitrate of, . . .	$NaONO_3$	Na_2NO_3
" phosphate of (bibasic), . . .	$2NaOHOPO_5$	HNa_2PO_4
Tin, ...	Sn	No change.
" bisulphide of, . .	SnS_2	"
" crystals of, . .	$SnCl+2HO$	$SnCl_2+2H_2O$
" murexide of, . .	SnO	SnO
" pink salts of, . .	$SnCl_2+2NH_4Cl$	$SnCl_4+2NH_4Cl$
" protochloride of, .	$SnCl$	No change.
" prussiate of, . .	$3SnCy,Fe_2Cy_3$	$Sn_3Fe_2Cy_{12}$
" ferricyanide of, . .	–	–
" stannic acid of, . .	SnO_2	No change.
Water, ...	HO	H_2O
Zinc, ...	Zn	No change.
" acetate of, . .	$C_4H_3ZnO_4$	$Zn(C_2H_3O_2)_2$
" carbonate of, . .	$ZNOCO_2$.	$ZnCO_3$
" chloride of, . .	$ZnCl$	$ZnCl_2$
" nitrate of, . .	$ZnONO_5$	$ZnNO_3$
" sulphate of, . .	$ZnOSO_3$	$ZnSO_4$
Organic Compounds.		
Magdala red, . . .	–	$C_{30}H_{21}N_3$—
Carthamine, ...	–	$C_{14}H_{16}O_7$—
Isopurpurate of potash, .	–	$C_8H_4KNO_5$—
Alloxan, ...	–	$C_4H_4N_2O_5$—
Benzole, ...	–	C_6H_6
Nitro-benzole, . . .	–	$C_6H_5(NO_2)$
Mauveine, ...	–	$C_{26}H_{24}N_4$
Phenyl, ...	–	C_6H_5
Oxide of phenyl, . .	–	$(C_6H_5)_2O$
Iodine green crystals, .	–	$C_{25}H_{33}N_3OI_2$
Hydrated carbolic acid, .	–	$C_6H_6O+H_2O$
Naphthaline, ...	–	$C_{10}H_8$
Base of naphthaline red,	–	$C_{30}H_{21}N_3$
Naphthaline yellow, .	–	$C_{10}H_6(NO_2)_2O$
Nitro-naphthaline, . .	–	$C_{10}H_7NO_2$
Bibromoanthrachinon, .	–	$C_{14}H_6Br_2O_2$
Methylaniline, . . .	–	$C_6H_6(CH_3)N$
Diphenylamine, . . .	–	$C_{12}H_{11}N$
Naphthylamine, . . .	–	$C_{10}H_9N$
Triphenylic rosaniline, .	–	$C_{20}H_{16}(C_6H_5)_3N_3$
Indigotine, ...	–	$C_{16}H_{10}N_2O_2$
Isatine, ...	–	$C_{16}H_{10}N_2O_4$
Indican, ...	–	$C_{26}H_{33}NO_{18}$
White indigo, . . .	–	$C_{16}H_{12}N_2O_2$

Table of Symbols and Formulas—Con.

	Old Notation.	New Notation.
Indigo glucine,	–	$6C_6H_{10}O_6$
Carmine red,	–	$C_{11}H_{12}O_7$
Curcumine,	–	$C_{10}H_{10}O_5$
Quercitrine,	–	$C_{33}H_{30}O_7+OH_2$
Dextrose,	–	$C_6H_{12}O_6$
Anthrapurpurine,	–	$C_{14}H_8O_5$
Purperine,	–	$C_{14}H_8O_5$
Alizarine,	–	$C_{14}H_8O_4$
Anthracene,	–	$C_{14}H_{10}$
Alizarate of potash,	–	$K_2O_4C_{14}H_6$
Protocatechuic acid,	–	$C_7H_6O_4$
Orcine,	–	$C_7H_8O_2$
Morin,	–	$C_{12}H_{10}O_6$
Braziline,	–	$C_{22}H_{18}O_7$
Luteoline,	–	$C_{20}H_{14}O_8$
Santaline,	–	$C_8N_6O_3$
Ethyl alcohol,	–	C_2H_6O
Methyl alcohol,	–	CH_4O
Ethyl,	–	C_2H_5
Methyl,	–	CH_3
Iodide of ethyl,	–	C_2H_5I
Anthraquinone,	–	$C_{14}H_8O_2$
Aniline,	–	$C_6H_5NH_2$
Aniline yellow (soluble in alcohol),	–	$C_{20}H_{19}N_2O_6$
Rosaline white,	–	$C_{20}H_{19}N_3$
Rosaniline red,	–	$C_{20}H_{19}N_3OH_2$

SPECK DYES.

For Brown.

25 lbs. Extract Logwood,
30 lbs. Copperas,
30 lbs. Sumac.

Run three pieces at a time over the reel for twenty minutes, at a heat of 125° Fahr.

For the next three pieces, add

6 lbs. Sumac,
5 lbs. Extract Logwood,
7 lbs. Copperas,

and proceed as for first three pieces.

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This last addition must be made for every three pieces.

The pieces are double-width beavers, weighing sixty pounds to the piece.

Boil out the sumac in a separate tub or barrel, and use the clear liquor only.

Wash off the pieces before you speck-dye them, also after being speck-dyed.

For Black or Blue.

Take a barrel that will hold two hundred and twenty gallons of water; fill it half full of water. Add to it eighty pounds soda-ash; boil until it is dissolved. Then add eighty pounds liquid extract of logwood (specific gravity, 51°); boil twenty minutes.

Now dissolve twenty pounds blue vitriol in as little water as possible; then put a piece of iron pipe (the larger in diameter the better) into the solution, and turn the blue-vitriol solution down the pipe, a little at a time. By so doing you will prevent its foaming, and will not cause so much sediment to settle at the bottom.

After you get all the blue vitriol in, fill up the barrel with water.

Use one pail of this to every piece weighing sixty pounds, that you run at a time; that is, after your speck-tub has been set.

To Set the Speck-Dye.

To a tub that you intend to speck-dye in, that will hold four or five hundred gallons, add all of the above-described solution; then fill up to the proper working height. Work the speck-dye at 130° Fahr.

For Green Felts.

Take three pails of copperas, dissolve it in a barrel of water. Into a tub of cold water put fifteen quarts of this solution for the first seven pieces; give the cloth four ends; take out and run into the prussiate-tub. For the next seven

pieces, give seven quarts of the copperas solution. For the next seven pieces, give four quarts of the solution. Give four ends for each seven pieces. This last is the standard solution.

Dissolve ten pounds red prussiate in one-half barrel of water. Into a tub of cold water put fifteen quarts of the solution, and one quart oil of vitriol;* six ends for each seven pieces. For the second seven pieces, give seven quarts of prussiate solution; give six ends. For the next seven pieces, give four quarts prussiate solution; give six ends. This last is the standard solution.

After coming out of the prussiate-tub, the pieces must be washed off.

* One pint for every seven pieces, after the first seven pieces.

CLOTH SAMPLES.

No. 1.—Blue-black.

No. 2.—Brown.

No. 3.—Blue.

No. 4.—Blue Melton.

No. 5.—Blue Melton.

No. 6.—Black.

REMARKS ON PIECE-DYEING (see p. 136).

In the first place the pieces should be thoroughly washed after being fulled and scoured, as any grease or soap left in the pieces acts as a deadly obstacle to the coloring of them; therefore, care should be taken to clear them well out, as greasy or soapy pieces cause the dyer more trouble than all the rest of the difficulties with which he has to contend. If the pieces are greasy or soapy, in nine cases out of ten he will have them full of *light*-colored *places* or *clouds*, and whenever you have such places in the pieces, you may be doubly sure that the grease or soap is not washed out of them, for it is almost an impossibility in piece-dyeing to have light clouds or places in them caused by either the manipulations or dye-stuffs. Where pieces are clouded by the dyeing you will *always* find them to be *darker* than the whole piece, *not lighter.*

After they are washed off they should get all the gigging intended to be given them, and if they can be cropped some before dyeing, it would make a great improvement in the intensity of the color; and for these reasons:—if they have to be gigged much after they are dyed, the friction of the gig makes the color look gray; and besides, if they are dyed without cropping, the long nap on them acts as a filter to the color, and prevents the coloring matter from penetrating into the body of the cloth. Consequently, after they are dyed, and the nap is sheared off, you will perceive that the color is much lighter than you expected, for the reason that the best part of the color has been sheared off.

Every dyer should insist upon having his pieces come to him PERFECTLY CLEAN, for he has enough to contend with in piece-dyeing without having greasy or soapy cloth sent to him from the fulling-room.

The pieces should be prepared one day and finished the next; and after they are dyed, do not wash them off the same day if it can be avoided, or at least do not allow them to go

directly to the wash-box, but give the color time to fix itself fairly. Wash off all colors with cold water only, except in some particular cases. If the cloth has to be speck-dyed, do not do it until the day after they are colored.

The cloth samples are made from thirty-five per cent. wool and sixty-five per cent. shoddy; both in the warp and filling the shoddy contains a large amount of cotton threads.

In speck-dyeing, the black and blues should be done on rollers, two pieces at a time, and run them about twenty-five minutes.

The blues are specked in the same tub and the same dye as the black. Be particular to observe the degrees of heat with each recipe.

All these cloths are six-quarters wide.

Bail the dye-woods one and a half hours, unless otherwise stated in the recipe.

In finishing the cloth, always cool down the dye before entering the cloth. In the recipes you will find that tartarine is used. (See article, Tartarine.) If you have not got it, use one-third more of red tartar than is named of tartarine; that is, if the recipe calls for six pounds tartarine, use eight pounds red tartar in its place.

If you are obliged to finish the cloth on the same day that it is prepared, be sure and cool off the cloth from the preparation thoroughly.

RECIPES FOR CLOTH, WITH SAMPLES.

Blue–black Chinchillas.

No. 1. 1 piece, 45 yards, 100 lbs.

Prepare with—

3 lbs. Chrome,
3 lbs. Blue Vitriol,
$1\frac{3}{4}$ lbs. Tartarine.

Boil cloth two hours.

Finish with—

60 lbs. Chip Logwood,
2 lbs. Camwood.

Boil cloth two hours. Speck-dye at 130° (see recipe for speck-dye).

For a Jet Black on same Goods.

Six pieces, 480 lbs.

Prepare with—

12 lbs. Chrome,
6 lbs. Tartarine,
8 lbs Blue Vitriol.

Boil cloth two hours.

Finish with—

150 lbs. Chip Logwood,
20 lbs. Chip Fustic.

Boil cloth two hours. Speck-dye at 150°.

Brown.

No. 2. 6 pieces heavy Chinchilla, 520 lbs.

Prepare with—

12 lbs. Chrome,
12 lbs. Tartarine,
2 lbs. Alum.

Boil cloth two hours.

Finish with—

45 lbs. Extract Fustic,
45 lbs. Madder,
100 lbs. Camwood,
20 lbs. Ground Logwood,
20 lbs. Sanders,
20 lbs. Barwood,
5 lbs. Extract Hypernic.

Throw these into the kettle loose, and boil twenty minutes; then cool down and enter the cloth, and boil one and three-

quarters hours. Take out and wash off. Extract the water out of them, and speck-dye at 130° (see speck-dye for brown).

The extract of fustic and hypernic you must dissolve before putting it into the tub.

Blue.

No. 3. 6 pieces Chinchilla, 452 lbs.

Prepare with—

15 lbs. Alum,
8 lbs. Oxalic Acid,
2½ lbs. Chrome.

Boil cloth one and three-fourths hours.

Finish with—

5 lbs. Ground Hypernic,
6 lbs. Cudbear,
100 lbs. Chip Logwood.

Boil one and a half hours; then cool down and enter cloth, and boil two hours; speck-dye at 130°.

Blue.

No. 4. 8 pieces light-weight Meltons, 388 lbs.

Prepare with—

12 lbs. Alum,
7 lbs. Oxalic Acid,
1¾ lbs. Chrome,
¼ lb. Tin Crystals.

Boil cloth one and three-fourths hours.

Finish with—

110 lbs. Chip Logwood,
6 oz. Tin Crystals.

Cool down and enter cloth. Boil cloth one and three-fourths hours; speck-dye at 130°.

Blue.

No. 5. 8 pieces heavy-weight Meltons, 490 lbs.

Prepare with—

1 lb. Chrome,
12 lbs. Alum,
8 lbs. Oxalic Acid,
1 lb. Tin Crystals.

Boil cloth one and three-fourths hours.

Finish with—

100 lbs. Chip Logwood.

Cool down; enter cloth. Boil one and three-fourths hours; speck-dye at 170°.

Black.

No. 6. On cotton warp, worsted filling, and cotton and shoddy backing, forty per cent. cotton in the back filling. Narrow-width cloth, fourteen ounces to the yard, thirty yards in a piece.

First. Dissolve thirty pounds copperas, and ten pounds white sugar of lead; put it into a barrel, and fill it up with water.

To prepare ten pieces, take one pailful of the copperas and lead solution, add it to the tub you are to prepare in; now add five pounds blue vitriol to it, and the clear liquor from one pail of sumac. Run the pieces one and a half hours at a boil. Take out, air well, and leave until next day to finish.

This preparation can be kept until you run forty pieces; after that throw it away.

For each succeeding ten pieces use one pail of the copperas and lead solution, five pounds blue vitriol, and the clear liquor from one pail of sumac, as stated above.

Finishing or roller-tub—

To set: 100 lbs. Extract of Logwood,
100 lbs. Soda-ash,
22 lbs. Blue Vitriol.

Take five pieces at a time, give them five ends, then take them out and air them; re-enter them and give them five more ends; take out and wash off the next day. This tub is kept on the boil all the time the pieces are in it.

For the next five pieces, add to the tub—

13 lbs. Extract of Logwood,
13 lbs. Soda-ash,
1½ lbs. Blue Vitriol,

and proceed as for the first five pieces.

Should the pieces come out a little on the purple shade, reduce the dyestuffs to

10 lbs. Extract of Logwood,
10 lbs. Soda-ash,
1¾ lbs. Blue Vitriol.

To get a blue-black, use—

4 lbs. Extract of Hemlock,
8 lbs. Extract of Logwood,
11 lbs. Soda-ash,
2½ lbs. Blue Vitriol,

for each five pieces.

To set for a blue-black—

80 lbs. Extract of Logwood,
25 lbs. Extract of Hemlock,
90 lbs. Soda-ash,
25 lbs. Blue Vitriol.

This makes a splendid blue-black on these kinds of goods.

Prussian Blue.

Six pieces Cloth, 300 lbs.

Prepare with—

40 lbs. Red Prussiate of Potash,
8 oz. Nitric Acid,
6 oz. Sulphuric Acid.

Enter at 140°, and bring to a boil slowly, and boil half an hour.

Finish with two hundred pounds chip logwood, boil out the logwood, cool down to 170°, then add—

4 lbs. Tin Crystals,
4 lbs. Oxalic Acid,
4 lbs. Tartar.

Rake up well. Enter cloth, and bring to a boil, and boil one hour.

Rich Full Blue.

Six pieces heavy Beavers, 330 lbs.

Prepare with—

13 lbs. Alum,
4 lbs. Oxalic Acid,
1 quart Scarlet Spirits,
1 pint Ammonia,
60 lbs. Chip Logwood.

Boil out first; then cool down, and add the spirits, ammonia, alum, and acid. Rake up and enter cloth. Boil for one and a half hours; take out and wash off.

To make the scarlet spirits: Take thirty-four pounds water, add to it seventeen pounds nitric acid, and three pounds muriatic acid; add five pounds feathered tin. Gradually, when it is all dissolved, add to it four and a half pounds oil of vitriol; stir up well; do not use it until it has been made twenty-four hours.

Prussian Blue.

500 lbs. Worsted Serges.

Prepare with—

40 lbs. Red Prussiate of Potash,
4 lbs. Oil of Vitriol,
4 lbs. Nitric Acid.

Enter at 140°. Bring up to a boil gradually, and boil one hour. Take out and air well.

Finish with —

300 lbs. Chip Logwood.

Boil it out. Then cool down, and add to it —

5 lbs. Tin Crystals,
5 lbs. Alum,
2 lbs. Oxalic Acid.

Enter, and bring to a boil, and boil one and one-fourth hours. Take out, and wash off.

Light Blue.

4 pieces Worsted Warps, 210 lbs.

Prepare with—

$1\frac{1}{2}$ lbs. Chrome,
7 lbs. Alum,
3 lbs. Oxalic Acid,
2 lbs. Tin Crystals.

Enter cloth, and boil one and one-half hours.

Finish with —

30 lbs. Chip Logwood.

Enter cloth at 180°. Bring up to a boil, and boil one and one-fourth hours. Speck-dye at 120° heat.

Black.

4 pieces, 15 ounces per yard, 150 lbs.

Prepare with—

16 lbs. Chip Fustic,
8 lbs. Chip Logwood.

Boil these one and one-half hours. Then add—

6 lbs. Copperas,
6 lbs. Blue Vitriol.

Rake up. Boil cloth one and three-fourths hours.

Finish with —

130 lbs. Chip Logwood,
7 lbs. Chip Fustic.

Boil cloth one and one-half hours.

Prussian Blue (Indigo Shade).

100 lbs. Beaver Cloth.

Prepare with—

6 lbs. Red Prussiate of Potash,
1 quart Muriatic Acid,
1 quart Oil of Vitriol,
70 lbs. Chip Logwood.

Boil out the logwood. Then cool down to 140°, and add the prussiate and the acids. Enter the cloth; put on the steam, and boil to a good green color. Then take it out, and air well.

Add to the liquor —

2 lbs. Tin Crystals,
4 lbs. Alum,
1 lb. Oxalic Acid.

Rake up well. Enter the cloth, and boil for one hour, or till the shade suits you.

Blue Worsted Warp.

2 pieces, 50 yards, 104 lbs.

Prepare with—

¾ lb. Chrome,
3 lbs. Alum,
1½ lbs. Oxalic Acid,
1 lb. Tin Crystals.

Boil cloth one and one-half hours.

Finish with —

20 lbs. Chip Logwood.

Enter cool, and boil one hour. Then speck-dye in cold speck-dye.

Black.

4 pieces, 28 ounces per yard, 200 lbs.

Prepare with—
6 lbs. Chrome,
5 lbs. Blue Vitriol,
2 lbs. Tartarine.
Boil cloth one and three-fourths hours.

Finish with—
130 lbs. Chip Logwood,
20 lbs. Chip Fustic.
Boil cloth one and one-half hours.

Olive.

6 pieces Beavers; weight, 264 lbs.

Prepare with—
6 lbs. Chrome,
6 lbs. Tartarine.
Boil one and one-half hours.

Finish with—
90 lbs. Chip Fustic,
12 lbs. Madder,
45 lbs. Chip Logwood.
Boil two hours. Air the cloth well, and wash off.

Green Olive.

6 pieces Beavers, 246 lbs.

Prepare with—
6 lbs. Chrome,
6 lbs. Tartarine.
Boil cloth one and one-half hours.

Finish with —

65 lbs. Chip Fustic,
12 lbs. Madder,
15 lbs. Camwood,
33 lbs. Chip Logwood.

Boil cloth two hours. Wash off.

Brown Olive.

6 pieces Beavers, 240 lbs.

Prepare with—

6 lbs. Chrome,
6 lbs. Tartarine.

Boil cloth one and one-half hours. Air well.

Finish with —

100 lbs. Chip Fustic,
18 lbs. Madder,
38 lbs. Chip Hypernic,
16 lbs. Logwood.

Boil cloth two hours. Air well, and wash off.

Brown.

6 pieces Beavers, 260 lbs.

Prepare with—

6 lbs. Chrome,
6 lbs. Tartarine.

Boil cloth one and one-half hours.

Finish with —

75 lbs. Chip Fustic,
12 lbs. Madder,
40 lbs. Camwood.

Boil cloth two hours. Then sadden with twelve lbs. copperas, and boil a half hour longer.

Red Brown.

6 pieces Beavers, 260 lbs.

Prepare with—

6 lbs. Chrome,
2 lbs. Tartarine.

Boil the cloth one and one-half hours.

Finish with —

130 lbs. Chip Fustic,
18 lbs. Madder,
100 lbs. Chip Hypernic,
10 lbs. Chip Logwood.

Boil the cloth one and three-fourths hours. Then sadden with two lbs. blue vitriol, and boil one hour longer.

Reddish Brown.

6 pieces Beavers.

Prepare with—

$5\frac{1}{2}$ lbs. Chrome,
4 lbs. Tartarine.

Boil the cloth one and three-fourths hours. Air well. Then Finish with —

100 lbs. Chip Fustic,
13 lbs. Madder,
10 lbs. Chip Logwood,
100 lbs. Chip Hypernic.

Boil the cloth one and three-fourths hours. Then sadden with three lbs. blue vitriol, and boil one hour longer.

Dahlia.

6 pieces Chinchilla, 482 lbs.

Prepare with—

8 lbs. Chrome,
$7\frac{1}{2}$ lbs. Tartarine.

Boil the cloth one and three-quarters hours.

Finish with—
48 lbs. Ground Hypernic,
10 lbs. Cudbear,
10 lbs. Extract of Hypernic,
15 lbs. Ground Logwood.

Boil the cloth two hours. Next day, speck-dye at 120°, and give four ends. Wash off.

Dahlia.

6 pieces Beavers, 252 lbs.

Prepare with—
6 lbs. Chrome,
4 lbs. Blue Vitriol,
2 lbs. Oxalic Acid,
1 quart Oil of Vitriol.

Boil the cloth one and one-half hours.

Finish with—
90 lbs. Chip Hypernic,
6 lbs. Cudbear,
30 lbs. Camwood,
7 lbs. Chip Logwood.

Boil the cloth two hours. Wash off in fuller's earth.

Claret.

6 pieces Beavers, 252 lbs.

Prepare with—
6½ lbs. Chrome,
6½ lbs. Tartarine.

Boil the cloth one and three-fourths hours.

Finish with—
180 lbs. Camwood,
15 lbs. Logwood,
15 lbs. Fustic.

Boil the cloth two hours. Then sadden with
$3\frac{1}{2}$ lbs. Blue Vitriol,
6 lbs. Copperas.
Boil one half-hour. Wash off.

FELT GOODS.

Aniline Colors.—Blues.

Guernsey (reddish).

Eight pieces Felts, 160 lbs.
1 lb. 7 oz. single B Guernsey blue,
$1\frac{1}{2}$ lbs. Sal soda.

Enter the cloth at 190°, bring up to a boil, and boil one hour.

It is immaterial whether you wash off from this or not.

Develop in a bath at 120°, to which add one gallon oil of vitriol; run the cloth at this temperature for half an hour; take out and wash the cloth in cold water.

If you should wish for a very dark shade, top the above off in a fresh bath at 200°, with seven ounces Hoffmann two B's violet, which produces a very handsome shade.

China and Serge Blue.

Four pieces Felt, 80 lbs.

Dissolve ten ounces China blue crystals in two pails of hot water, with one pound oil vitriol; add this to the dye-tub; then dissolve ten ounces serge blue in the same amount of water, but do not use any acid. Add this to the tub, rake it up, then add one pound more of oil vitriol; rake up, enter cloth at 130°, run and boil for half an hour. Take out and wash off.

Nicholson Blue.

Ten pieces Felt, 200 lbs.

Dissolve two and three-quarters pounds refined borax; add it to the tub. Dissolve one pound six ounces Nicholson four

B's fast blue; add it to the tub. Enter the cloth at 130°, heat up to 190°, run for half an hour, take out and air well. Develop in a fresh bath at 120°, to which add two quarts oil vitriol; run the cloth twenty minutes, take out and wash off.

China Blue (new).

Eight pieces Felt, 160 lbs.

Dissolve one pound China blue crystals with two pounds diluted oil vitriol; add it to the tub. Then dissolve fourteen ounces more of the crystals in the same amount of acid; add this also to the tub. Then add twelve pounds oil vitriol; rake up the tub well. Enter the cloth at 130°; run the cloth at a boil for fifteen minutes; take out and wash off.

Nicholson Blue.

Eight pieces Felt, 112 lbs.

Dissolve two pounds borax; add to the tub. Dissolve one pound fourteen ounces Nicholson fast blue, three B's. Proceed as for the other Nicholson blue. Develop in fresh bath at 130°, to which add three quarts oil vitriol; run cloth twenty minutes; take out and wash off.

For the next eight pieces, add to first tub twenty-five ounces Nicholson three B's. To developing-tub add three pints oil vitriol; and the same for every eight pieces thereafter.

Silver Drab.

Eight pieces Felt, 160 lbs.

Dissolve half a pound silver-drab crystals in half a pint of acetic acid; add it to the tub. Add also one quart oil vitriol; rake up the solution well. Enter the cloth at 120°, bring up to a boil, and boil one hour; take out and wash off.

If you should want a bluer shade, use more oil vitriol. If wanted more on the lavender shade, use no oil vitriol.

Another Shade of the Same Color.

Proceed as above, and when you reel up the cloth add to the bath four pounds madder; boil it for five minutes, then

add three ounces of copperas. Drop the cloth in again, and boil for half an hour; take out and wash off.

These drabs can be varied by adding more madder. Another very good shade is obtained by using nine pounds of madder.

Violet.

Eight pieces Felt, 160 lbs.

Dissolve thirteen ounces Hoffmann two B's in hot water; add to the bath; rake up well. Enter the cloth at 110°, run twenty minutes, bring up to 140°, take up the cloth on the reel. Then add to the tub thirteen ounces more of the crystals, dissolved as before; run cloth ten minutes, then bring up to 190°; run for ten minutes more; take out and wash off.

For other violets, if wanted bluer, use oil of vitriol with the dye. The marks of violets are: the more B's, the bluer the shade they give.

Scarlet.

100 lbs. Felt Cloth, 4 pieces.

10 lbs. Cochineal,
2½ lbs. Tin Crystals,
2½ lbs. Oxalic Acid,
½ lb. Flavine,
2½ lbs. Tartar,
2½ pints Muriate of Tin.

Boil these for fifteen minutes; then cool down tub; enter cloth; put on steam and boil forty minutes; take out and wash off. This is a splendid shade.

Scarlet (more on the red shade than the above).

100 lbs. Felts, 4 pieces.

11 lbs. Cochineal,
4½ lbs. Tartarine (see article Tartar),
4 ounces Flavine,

1 lb. Oxalic Acid,
1 ounce Roseine,
2 quarts Muriate of Tin.

Proceed as above. Boil one hour and wash off.

SCARLET.

160 lbs. Felts, 8 pieces.

12 lbs. Cochineal,
$\frac{1}{2}$ lb. Flavine,
4 lbs. Refined Tartar,
2 lbs. Oxalic Acid,
6 quarts Scarlet Spirits.

Boil these for fifteen minutes. Cool down to 140°. Enter cloth. Put on steam and boil three-fourths hour. Wash off.

SCARLET.

140 lbs. Felts, 6 pieces.

10 lbs. Cochineal,
4 lbs. Tartarine,
$1\frac{1}{2}$ lbs. Oxalic Acid,
10 ounces Flavine,
6 quarts Muriate of Tin.

Proceed as above, and boil one hour.

PEARL-DRAB.

104 lbs. Felts, 4 pieces.

Prepare with—
$2\frac{1}{2}$ lbs. Chrome,
$2\frac{1}{2}$ lbs. Alum,
$2\frac{1}{2}$ lbs. Tartarine.

Boil cloth one and a half hours.

Finish with—

7 ounces Nutgalls,
7 ounces Ground Logwood,
1½ ounces Cudbear,
1½ ounces Ground Fustic.

Boil these twenty minutes. Enter cloth and boil one hour.

Lead-Drab.

100 lbs. Felts, 4 pieces.

Prepare as for pearl-drab.

Finish with—

2½ lbs. Ground Logwood,
2¼ lbs. Nutgalls,
6 ounces Cudbear.

Proceed in all respects as for pearl-drab.

Bright Blue.

100 lbs. Felts, 4 pieces.

Prepare with—

1 lb. Chrome,
2½ lbs. Alum,
1½ lbs. Oxalic Acid.

Boil cloth one and a half hours.

Finish with—

16 lbs. Chip Logwood.

Boil for one and a half hours, then add three ounces Hoffmann's 2 B's violet. Enter cloth at 170° Fahr. Put on steam and boil one and one-fourth hours.

Nicholson Blue (Cotton back).

4 pieces, 92 lbs.

10 ounces Guernsey blue, A,
1 lb. Soda-ash,
2 ounces Hoffmann's 2 B's, violet.

Enter cloth as 180°, put on steam, and boil three-fourths of an hour.

Develop at 120° Fahr. with—
2 quarts Oil of Vitriol.

Run cloth three-fourths of an hour. Take out and wash off.

Olive.

175 lbs. Felts, 8 pieces.

Prepare with—
5 lbs. Chrome,
4 lbs. Alum.

Boil cloth one and three-fourths hours next day.

Finish with—
56 lbs. Chip Fustic,
40 lbs. Madder,
6 lbs. Logwood.

Boil these one and a half hours. Cool down. Enter cloth and boil one and a half hours.

A Rich Olive.

250 lbs. Felts, 10 pieces.

Prepare with—
7 lbs. Chrome,
7 lbs. Glauber Salts,
5 lbs. Oil of Vitriol.

Boil cloth one and a half hours.

Finish with—

75 lbs. Chip Fustic,
70 lbs. Madder,
20 lbs. Chip Logwood,
60 lbs. Camwood.

Boil all these two hours, then cool down and add five lbs. glauber salts. Enter cloth, Put on steam, and boil one and three-fourths hours.

If the felts have many burrs or specks, you must speck-dye them with sumac and copperas, cold—first, in a sumac-bath, then in the copperas-bath.

Dark Green.

200 lbs. Felts, 8 pieces.

Prepare with—

3 lbs. Chrome,
10 lbs. Alum,
10 lbs. Glauber Salts,
5 lbs. Oxalic Acid,
5 lbs. Tin Crystals,
5 lbs. Oil of Vitriol.

Boil cloth one and a half hours, then take out and wash off.

Finish with—

23 lbs. Chip Fustic,
20 lbs. Chip Logwood,
13 lbs. Extract of Indigo.

Boil the fustic and logwood one and a half hours; then add the indigo. Boil fifteen minutes. Cool down, enter cloth, and boil two hours.

Green.

126 lbs. Felts, 7 pieces.

15 lbs. Alum,
10 lbs. Extract of Indigo,
2 lbs. Picric Acid.

Boil these for twenty minutes; then cool down; enter the cloth and boil one hour; then speck-dye.

Speck-Dye for Green Felts.

Take 3 pails of copperas; dissolve it in one barrel of water. Into a tub of cold water put 15 quarts of this solution for the first 7 pieces. Give them 4 ends. Take out and run into the other tub. For the next 7 pieces add seven quarts of the copperas solution, and procees as for the first 7 pieces. For the next seven pieces use 4 quarts of the solution and proceed as before. This last will be the standard.

Second tub,—

Dissolve 10 lbs. red prussiate potash in a half-barrel of cold water.

Into the second tub (cold) put, for first 7 pieces, 15 quarts of prussiate solution. Give 6 ends. For second 7 pieces, 7 quarts prussiate solution. Give 6 ends. For next 7 pieces, 4 quarts prussiate solution. Give 6 ends.

This last is the standard for the second tub.

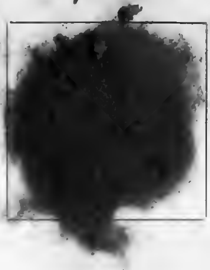
Wash off the pieces after coming out of the prussiate-tub.

WOOL SAMPLES.

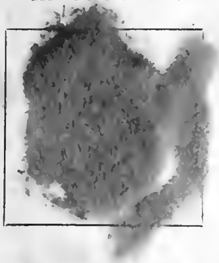
No. 1.
Garnet-Drab.

No. 2.
Drab.

No. 3.
Stone-Drab.

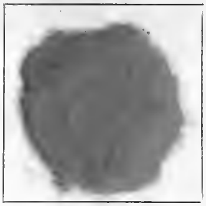


No. 4.
Aniline Drab.



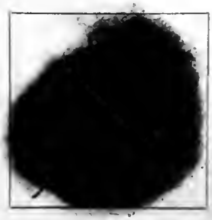
No. 5.
Yellow-Orange.

No. 6.
Full Orange.



No. 7.
Lavender.

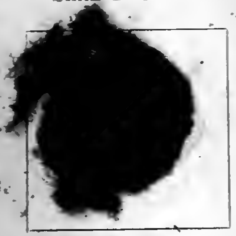
No. 8.
Fast Nicholson
Blue.



No. 9.
Fast Nicholson
Blue, Dark.

WOOL SAMPLES.

No. 10.
SEAL BROWN.



No. 11.
BROWN.

No. 12.
CINNAMON-BROWN.

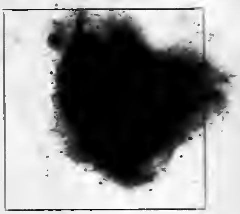
No. 13.
OLIVE.

No. 14.
LIGHT CINNAMON-BROWN.

No. 15.
RED-BROWN.

No. 16.
OLIVE-BROWN.

No. 17.
DARK CARDINAL-RED.

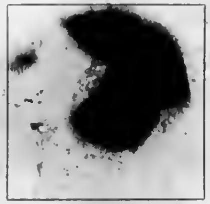


No. 18.
BLUE-VIOLET.

WOOL SAMPLES.

No. 19.
BLUE.

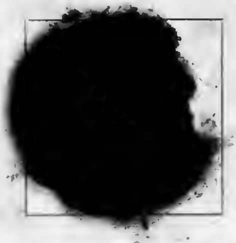
No. 20.
PLUM.



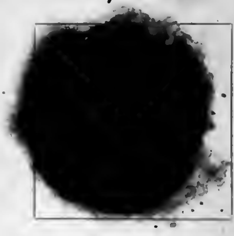
No. 21.
GREEN.

No. 22.
SMOKE-GREEN.

No. 23.
BLUE-GREEN.



No. 24.
FULL GREEN.



REMARKS ON RECIPES FOR WOOL.

The number of pounds for each recipe, is for wool in the grease (that is, wool before it is scoured), unless otherwise stated in the recipe. The wool in all cases should be well poled before the steam is turned on, and during the time it is boiling, it is a very good plan to shift the position of it in the tub, by using the pole once or twice during the ebullition.

We have given but few samples of colors, but there is enough for a guide, as a dyer can vary the materials of the different recipes, according to his judgment, so as to obtain the shade desired, by comparing his sample with sample in the book, and making such variations as required, either in the yellow, blue, or red coloring materials.

The dye-woods must be boiled one and a half hours before entering the wool, and the same time for the wool, unless otherwise stated in the recipe. All the ground *woods* should be thrown into the tub loose, except camwood, sanders, and barwood, if in large quantities, which must be sprinkled upon the wool before it is thrown into the tub.

When coloring yellow and other light shades, be particular to have the tub thoroughly cleaned, and everything connected with the dyeing of them perfectly clean. After preparing the wool, do not finish until the next day, as the colors will be more intense and brighter by so doing.

RECIPES FOR WOOL, WITH SAMPLES.

Granite-Drab.

No. 1. Fifth quality American, 350 lbs.

4 lbs. Ground Logwood,
$\frac{1}{2}$ lb. Cudbear,
6 oz. Nutgalls,

1 lb. Ground Fustic,
1 lb. Red Tartar.

After boiling these half an hour, enter the wool very quickly, and pole up well. (The tartar should not be put in until the other materials are boiled out for half an hour.)

After boiling the wool for one and a half hours, sadden with—

1 lb. Blue Vitriol,
1 lb. Red Tartar,
3 oz. Copperas.

Boil half an hour; then draw off and throw out.

Drab.

No. 2. Third Fleece, 300 lbs.

Prepare with—

7 lbs. Ground Logwood,
1 lb. Nutgalls,
2 lbs. Sumac,
3 lbs. Red Sanders,
4½ lbs. Madder,
11 lbs. Ground Fustic.

Boil these twenty minutes; enter wool, and boil one and a half hours. Sadden with—

2½ lbs. Copperas,
¾ lb. Alum.

Boil half an hour, then draw off.

Stone-Drab.

No. 3. Fifth Fleece, 300 lbs.

Prepare with—

1½ lbs. Nutgalls,
2 lbs. Ground Logwood,
1¾ lbs. Ground Fustic,
1½ lbs. Madder,
¾ lb. Sumac.

Boil and proceed as for No. 2; then sadden with—

1 lb. Alum,
1 lb. Red Tartar,
¾ lb. Copperas.

Boil half an hour, than draw off.

Aniline Drab.

No. 4. Third Fleece, 316 lbs.

Prepare with—

10 oz. Silver-Gray Crystals (Poirrier).

Dissolve it in half a pint acetic acid; heat the tub to 150° Fahr.; add to it one quart of oil of vitriol; stir it up; then add the dissolved crystals, and rake up well; enter the wool, turn on the steam, and pole until it comes to the boil, and boil one and a half hours. This comes out a little uneven, but does not show it after being carded.

Yellow-Orange.

No. 5. Third Fleece, 20 lbs. clean.

Prepare with—

7 oz. Flavine,
¾ oz. Purpurine.

Boil these for half an hour, then cool down, and add—

¼ lb. Tin Crystals,
½ lb. Muriate of Tin,
¼ lb. Oxalic Acid.

Rake up well; enter the wool; pole up well. Boil half an hour; take out and wash off.

Full Orange.

No. 6. Third Fleece clean Wool, 100 lbs.

Prepare with—

4 lbs. Flavine,
10 oz. Purpurine.

Proceed as with No. 5, then add—

3 lbs. Tin Crystals,

$2\frac{1}{2}$ lbs. Oxalic Acid.

Enter wool, turn on steam, and pole up until the wool becomes even. Boil half an hour. This color improves in fulling and scouring, becoming brighter. It is a perfectly fast color, as regards light and alkalies.

If the water which you have to use contains lime, less purpurine will produce the shade.

Lavender.

No. 7. Third Australian, clean Wool, 80 lbs.

Prepare with—

2 lbs. Alum,

3 lbs. Red Tartar,

1 lb. Oil of Vitriol.

Boil wool one hour.

Finish with—

$\frac{3}{4}$ lb. Hoffmann Violet, 3 B's,

$\frac{1}{2}$ lb. Extract of Indigo (Chemic).

Boil wool half an hour. Leave it in the bath five hours.

If it should not come up red enough to suit you, sadden with one pound alum.

Fast Nicholson Blue.

No. 8. Third American, clean fleece Wool, 25 lbs.

Prepare with—

2 lbs. Chrome,

$\frac{3}{4}$ lb. Alum,

1 lb. Tin Crystals,

1 lb. Red Tartar.

Boil wool one hour.

Finish with—

1½ oz. Hoffmann Violet, 3 B's,

1½ oz. Nicholson'sBlue, 4 B's.

Boil wool one hour. Take out and develop in fresh bath, with one pint oil of vitriol. Heat 200° Fahr., pole up well, and leave in for one hour. Wash off.

Fast Nicholson Blue (Dark).

No. 9. Third Fleece, clean Wool, 20 lbs.

Prepare with—

4 oz. Fast Nicholson's Blue, 4 B's,

½ lb. Sal-soda.

Enter wool at 190 Fahr. Bring to a boil, and boil half an hour.

Finish in fresh bath with—

1¾ lbs. Oil of Vitriol,

1 oz. Hoffmann Violet, 2 B's.

Enter wool at 150° Fahr. Put on steam and boil half an hour. Then sadden with quarter of a pound of copperas, and boil half an hour longer. Take out and wash off.

Seal Brown.

No. 10. 100 lbs. clean Wool, 4th Fleece.

Prepare with—

3 lbs. Chrome,

3 lbs. Tartarine,*

¾ lb. Oxalic Acid.

Boil wool one and a half hours.

* Tartarine is a substitute for tartar. If you do not have it, use five pounds of half-refined tartar in place of tartarine. (See article, Tartar.)

Where tartarine is mentioned in the recipe, and you have not got it, use half-refined tartar, one-third more than weight of tartarine.

Finish with—

66 lbs. Chip Fustic,
7 lbs. Logwood,
22 lbs. Madder,
22 lbs. Camwood,
6 lbs. Red Sanders.

Boil these one and a half hours, and boil the wool two hours. Then sadden with—

1 lb. Copperas,
$\frac{3}{4}$ lb. Blue Vitriol,
2 lbs. Ground Logwood.

Boil wool half an hour longer.

Brown.

No. 11. 496 lbs. 4th American Fleece.

Prepare with—

$5\frac{1}{2}$ lbs. Chrome,
5 lbs. Tartarine,
1 lb. Oxalic Acid.

Boil wool one and a half hours.

Finish with—

130 lbs. Chip Fustic,
30 lbs. Madder,
20 lbs. Red Sanders,
55 lbs. Camwood,
5 lbs. Logwood.

Boil wool two hours; then sadden with—

10 lbs. Copperas,
4 lbs. Ground Logwood.

Boil half an hour longer, and draw off.

Cinnamon-Brown.

No. 12. 400 lbs. Fall California (shrinkage, 64 per cent.)

Prepare with—

4 lbs. Chrome,
3½ lbs. Alum.

Boil one and a half hours; next day

Finish with—

65 lbs. Camwood,
11 lbs. Madder,
50 lbs. Chip Fustic.

Boil wool two hours. Sadden with—

8 lbs. Copperas,
3½ lbs. Ground Logwood.

Boil half an hour longer, and draw off.

Olive.

No. 13. 200 lbs. Clean Wool.

Prepare with—

6 lbs. Chrome,
6 lbs. Tartarine.

Boil wool two hours.

Finish with—

80 lbs. Chip Fustic,
15 lbs. Madder,
8 lbs. Ground Logwood,
18 lbs. Camwood.

Boil wool two hours; then sadden with—

3 lbs. Copperas,
2 lbs. Blue Vitriol.

Boil half an hour longer.

Light Cinnamon-Brown.

No. 14. 330 lbs. 4th Fleece.

Prepare with—

4 lbs. Chrome,
4 lbs. Tartar,
1 lb. Oxalic Acid.

Finish with—

70 lbs. Chip Fustic,
16 lbs. Madder,
20 lbs. Camwood,
6 lbs. Red Sanders.

Boil wool one and a half hours; then sadden with—

1½ lbs. Blue Vitriol,
2 lbs. Copperas,
3 lbs. Ground Logwood.

Boil three-quarters of an hour, and draw off.

Red-Brown.

No. 15. 425 lbs. 4th Fleece.

Prepare with—

4¼ lbs. Chrome,
4¼ lbs. Tartarine.

Finish with—

100 lbs. Chip Fustic,
30 lbs. Madder,
15 lbs. Red Sanders,
50 lbs. Camwood,
5 lbs. Chip Logwood.

Boil wool one and three-quarter hours; then sadden with—

3 lbs. Blue Vitriol,

and boil half an hour longer.

Olive-Brown.

No. 16. 325 lbs. 5th Fleece.

Prepare with—

4 lbs. Chrome,
4 lbs. Tartarine.

Finish with—

40 lbs. Chip Fustic,
4½ lbs. Chip Logwood,
4 lbs. Madder,
22 lbs. Camwood.

Boil wool two hours; then sadden with—

1½ lbs. Blue Vitriol,
1 lb. Copperas.

Boil half an hour.

Dark Cardinal-Red.

No. 17. 50 lbs. clean Pulled Wool.

Prepare with—

15 lbs. Alum,
8 lbs. Tartarine,
2 lbs. Sal-Ammoniac.

Boil wool two hours; next day

Finish with—

14 lbs. Cochineal.

Boil wool two hours; leave it in the dye six hours. This is a perfectly fast color.

Another Cardinal-Red.

75 lbs. Clean Wool.

½ lb. Flavine,
12 oz. Golden Roseine.

Enter cool; bring to boil, and boil one hour. This is better adapted for yarn than wool.

Blue-Violet.

No. 18. 80 lbs. Clean Wool, 3d Fleece.

Prepare with—

3 lbs. Chrome,
3 lbs. Alum,
3 lbs. Tartarine.

Boil wool two hours; next day
Finish with—

$1\frac{1}{4}$ lbs. Hoffmann's 4 B's Violet (Poirrier's).

Boil one hour, and leave it in the tub three or four hours. This color resists alkalies and *sunshine* (light).

Blue.

No. 19. 500 lbs. 3d Fleece.

Prepare with—

$1\frac{1}{2}$ lbs. Chrome,
6 lbs. Alum,
4 lbs. Oxalic Acid,
2 lbs. Tartarine,
$\frac{3}{4}$ lb. Tin Crystals.

Boil wool one and a half hours.
Finish with—

60 lbs. Chip Logwood,
3 oz. Hoffmann's 2 B's Violet (Poirrier's).

Boil one and three-quarters hours.

Plum.

No. 20. 481 lbs. 3d Fleece.

Prepare with—

4 lbs. Tartarine,
4 lbs. Oxalic Acid,
$7\frac{1}{2}$ lbs. Alum.

Boil wool one and a half hours; next day

Finish with—

75 lbs. Chip Logwood,
15 lbs. Hypernic,
3 lbs. Cudbear.

Boil wool one and three-quarters hours; draw off.

Green.

No. 21. 40 lbs. Clean Wool, 4th Fleece.

Prepare with—

$2\frac{1}{4}$ lbs. Alum,
4 oz. Chrome,
3 oz. Tin Crystals.

Boil wool one and three-quarters hours.

Finish with—

$2\frac{1}{2}$ lbs. Ground Fustic,
7 lbs. Extract Indigo (Chemic),
1 quart Bran,
1 quart Salt (Coarse).

Boil these three-quarters of an hour; then cool down the tub. Enter the wool; pole up well, put on steam, and boil one and three-quarters hours; draw off.

Smoke-Green.

No. 22. 400 lbs. 3d Australian.

Prepare with—

6 lbs. Chrome,
$1\frac{1}{2}$ pints Oil of Vitriol,
5 lbs. Alum,
1 lb. Tin Crystals.

Boil wool two hours.

Finish with—

6 lbs. Chip Fustic,
16 quarts Salt,

58 lbs. Extract Indigo,
25 lbs. Bran,
10 lbs. Chip Logwood.

Boil out the fustic, bran and logwood, before you add the indigo and salt; then boil for twenty minutes longer. Cool down the tub, then enter the wool; pole up well, and boil one and three-quarters hours; after which you will sprinkle on

2 lbs. Ground Fustic,
8 lbs. Ground Logwood.

Boil one hour longer, then draw off, and throw out the wool immediately.

NOTE.—The greens must not be finished off until the *day after* they are *prepared.*

BLUE-GREEN.

No. 23. Clean, 3 lbs.; Fleece, 120 lbs.

Prepare with—

6 lbs. Alum,
$\frac{3}{4}$ lb. Chrome,
$\frac{1}{2}$ lb. Tin Crystals.

Boil wool one and three-fourths hours.

Finish with—

5 lbs. Ground Fustic,
3 quarts Bran,
20 lbs. Extract of Indigo,
3 quarts Salt.

Proceed as for No. 22. Boil wool one and one-fourth hours, or to shade.

FULL GREEN.

No. 24. Fall California (shrinks sixty-four per cent.), 400 lbs.

Prepare with—

10 lbs. Alum,
2 lbs. Chrome,
$2\frac{1}{2}$ lbs. Tin Crystals.

Boil wool two hours.

Finish with—

25 lbs. Chip Fustic,
8 lbs. Chip Logwood,
2 pails of Bran,
20 lbs. Extract of Indigo,
10 quarts salt.

Proceed as for No. 22, and boil wool one and one-half hours. Draw off, and throw out the wool.

Golden-Brown.

Fleece, 250 lbs.

Prepare with—

3 lbs. Chrome,
4 lbs. Alum,
3 lbs. Tartar.

Boil wool one and a half hours.

Finish with—

56 lbs. Chip Fustic,
12 lbs. Madder,
18 lbs. Camwood.

Boil drugs one and a half hours. Boil wool two hours.

A Dark Golden-Brown.

Fleece, 433 lbs.

Prepare with—

6 lbs. Chrome,
4 lbs. Alum.

Boil wool one and three-fourths hours.

Finish with—

130 lbs. Chip Fustic,
64 lbs. Camwood,
16 lbs. Logwood,
20 lbs. Madder.

Proceed as above.

Olive-Brown.

Australian Wool (shrinks sixty per cent.), 400 lbs.

Prepare with—

$4\frac{1}{2}$ lbs. Chrome,
$3\frac{3}{4}$ lbs. Alum,
$3\frac{3}{4}$ lbs. Tartar.

Boil one and a half hours.
Finish with—

60 lbs. Chip Fustic,
30 lbs. Camwood,
7 lbs. Madder,
6 lbs. Logwood.

Boil wool one and three-fourths hours.
Sadden with—

5 lbs. Copperas,
1 lb. Ground Logwood.

Boil one hour longer.

Red-Brown.

Third Australian, 450 lbs.

Prepare with—

$6\frac{3}{4}$ lbs. Chrome,
$6\frac{3}{4}$ lbs. Tartar,
2 lbs. Blue Vitriol.

Boil wool one and a half hours.
Finish with—

130 lbs. Chip Fnstic,
10 lbs. Madder,
40 lbs. Camwood,
10 lbs. Red Sanders,
8 lbs. Chip Hypernic.

Boil drugs one and a half hours. Boil wool one and three-fourths hours.

By saddening this with six lbs. copperas and one lb. ground logwood, you will obtain a good olive-brown color.

Light Olive.

Second Fleece, 300 lbs.

Prepare with—
- 5 lbs. Chrome,
- 5 lbs. Red Tartar,
- 5 lbs. Alum.

Boil wool two hours.

Finish with—
- 80 lbs. Chip Fustic,
- 10 lbs. Chip Logwood,
- 7½ lbs. Madder,
- 10 lbs. Camwood.

Boil wool two hours.

Green-Olive.

Third Fleece, 500 lbs.

Prepare with—
- 8 lbs. Chrome,
- 8 lbs. Red Tartar.

Finish with—
- 110 lbs. Chip Fustic,
- 8 lbs. Camwood,
- 15 lbs. Madder,
- 20 lbs. Chip Logwood.

Proceed as for light olive.

Cinnamon Color.

Monteviedo Wool, 500 lbs.

Prepare with—
- 6 lbs. Chrome,
- 6 lbs. Alum,
- 4 lbs. Red Tartar.

Finish with—

120 lbs. Chip Fustic,
12 lbs. Madder,
24 lbs. Camwood,
25 lbs. Chip Hypernic.

Boil wool two hours.

Yellow-Bronze.

Fribs, 500 lbs.

Prepare with—

7 lbs. Chrome,
6 lbs. Red Tartar,
6 lbs. Alum.

Finish with—

120 lbs. Chip Fustic,
20 lbs. Madder,
10 lbs. Logwood.

Boil the wool two hours. Leave it in for a few hours.

Bronze.

Third Fleece, 600 lbs.

Prepare with—

7 lbs. Chrome,
6 lbs. Tartar,
6 lbs. Alum.

Finish with—

80 lbs. Chip Fustic,
50 lbs. Camwood,
9 lbs. Chip Logwood,
10 lbs. Madder.

Boil wool two hours.

LIGHT BRONZE.

Fribs, 500 lbs.

Prepare with—

7 lbs. Chrome,
4 lbs. Red Tartar.

Finish with—

64 lbs. Chip Fustic,
10 lbs. Madder,
1 lb. Ground Logwood.

Boil wool one and a half hours.

LIGHT STAINS OR SHADES—YELLOW STAIN.

450 lbs. Second Fleece.

Prepare with—

2 lbs. Chrome,
2 lbs. Red Tartar.

Finish with—

4 lbs. Ground Fustic,
1½ lbs. Camwood,
1 lb. Madder.

Boil the wool in each bath one and a half hours.

PINK STAIN.

60 lbs. Cape Wool, clean.

Prepare with—

3 oz. Ground Logwood,
3 oz. Ground Fustic,
½ oz. Cudbear.

Boil the drugs fifteen minutes; then cool down; enter the wool; bring to a boil only; shut off the steam and let it remain in the solution for one hour.

Pearl Stain.

300 lbs. Second Fleece.

4 lbs Ground Logwood.

Boil it for fifteen minutes. Enter the wool; pole up *well;* boil one and a half hours; sadden with one lb. copperas; boil one-half hour longer.

These three are nice stains.

Drab Stain.

350 lbs. Fourth Cape Wool.

Prepare with—

2 lbs. Chrome,
1 lb. Tartar,
1 lb. Alum.

Finish with—

26 oz. Ground Fustic,
$1\frac{1}{2}$ lbs. Nutgalls,
18 oz. Brazilwood,
14 oz. Ground Logwood.

Boil the wool one and a half hours; then sadden with six oz. copperas. Boil one-half hour.

Lavender.

225 lbs. American Fleece.

Color in the vat to one-third blue; wash off the wool, and

Finish with—

4 oz. Cochineal,
5 oz. Madder,
$8\frac{1}{2}$ oz. Cudbear,

10 oz. Ground Logwood,
1½ oz. Nutgalls,
16 oz. Alum,
9 oz. White Tartar.

Boil the wool one and a half hours; then sadden with four and a half oz. copperas and boil one hour longer.

Lavender.

400 lbs. Second Fleece.

4 lbs. Ground Logwood,
1½ lbs. Cudbear.

Boil these one-half hour; then add one-half lb. cream of tartar. Boil the wool one and a half hours.

Sadden with—
1 oz. Copperas,
4 oz. Alum.

Boil one-half hour longer.

Dark Lavender.

200 lbs. American Fleece.

Color in the vat to one-third blue; then wash off, and

Finish with—
1½ lbs. Ground Logwood,
1½ lbs. Nutgalls,
1¼ lbs. Madder,
2½ lbs. Barwood,
¾ lb. Camwood,
¾ lb. Cudbear,
3 lbs. Alum.

Boil the drugs one half hour. Boil the wool two hours. If you should want this any darker, sadden with a little copperas.

Light and Bright Shades of Drabs — Hoffmann Drab.

500 lbs. Third Fleece.

Prepare with—

20 lbs. Alum,
3 lbs. Chrome,
4 lbs. Oil of Vitriol,
1½ lbs. Tin Crystals,
1 pail of Bran,

Boil the wool one hour.

Finish with—

2½ lbs. Ground Logwood.
1½ oz. Hoffmann's 3 B's Violet.

Boil the wool one and one-fourth hours.

Light Slate-Drab.

400 lbs. Second Fleece.

7 lbs. Ground Logwood,
3 lbs. Ground Fustic,
2½ lbs. Cudbear.

Boil these for twenty minutes, then add—

4 lbs. Red Tartar,
2 lbs. Alum,
1 lb. Copperas.

Rake up well; cool down and enter the wool; give it a good poling, and boil one and one-fourth hours.

Silver Drab.

250 lbs. Third Fleece.

1 lb. Madder,
2½ lbs. Ground Logwood,

½ lb. Cudbear,
½ lb. Nutgalls,
½ lb. Ground Fustic.

Boil out for twenty minutes; then add—
½ lb. Red Tartar,
½ lb. Copperas.
Proceed as for light slate-drab, and boil one hour.

Dove Drab.

200 lbs. Second Fleece.

Prepare with—
2 lbs. Alum,
¾ lb. Chrome,
½ lb. White Tartar.
Boil one hour.

Finish with—
½ lb. Ground Logwood,
11 ounces Brazil-wood.
Boil these one-half hour. Boil wool one-half hour.

Darker Dove-Drab.

263 lbs. Third Fleece.

Prepare with—
14 ounces Chrome,
14 ounces White Tartar,
2 lbs. Alum.
Boil wool one and a half hours.

Finish with—
1¼ lbs. Ground Logwood,
1½ lbs. Brazil-wood,
1 lb. Cudbear.
Boil these one-half hour. Boil wool one and one-quarter hours.

Blue-Drab.

208 lbs. Third Fleece.

Prepare with—

13 ounces Chrome,
2 lbs. White Tartar,
$3\frac{1}{2}$ lbs Alum.

Finish with—

26 ounces Ground Logwood,
1 lb. Cudbear,
8 ounces Brazil-wood.

Proceed as for the dark dove-drab.

Dove.

270 lbs. Second Fleece.

Prepare with—

18 ounces Chrome,
18 ounces Alum,
18 ounces Tartar.

Boil wool one hour.

Finish with—

21 ounces Ground Logwood,
21 ounces Nutgalls,
13 ounces Camwood,
$1\frac{3}{4}$ lbs. Madder,
$\frac{3}{4}$ lb. Ground Fustic.

Boil wool one and one-half hours.

Sadden with—

13 ounces Copperas.

Boil one-half hour.

Stone-Drab.

450 lbs. Fourth Cape Wool.

$3\frac{3}{4}$ lbs. Ground Logwood,
$1\frac{3}{4}$ lbs. Nutgalls,
2 lbs. Madder,
2 lbs. Fustic,
$\frac{1}{4}$ lb. Camwood.

Boil wool one and one-half hours.

Sadden with—

$1\frac{1}{2}$ lbs. Alum,
$1\frac{1}{2}$ lbs. Tartar,
2 lbs. Copperas.

Boil one-half hour longer.

Stone-Drab.

295 lbs. Second Fleece.

$1\frac{1}{2}$ lbs. Nutgalls,
$3\frac{3}{4}$ lbs. Ground Logwood,
$4\frac{1}{2}$ lbs. Ground Fustic,
15 ounces Camwood.

Boil wool one and one-half hours.

Sadden with—

$1\frac{3}{4}$ lbs. Copperas,
1 lb. Alum,
1 lb. Tartar.

Boil one-half hour longer.

Stone-Drab.

250 lbs. Third American Fleece.

3 lbs. Ground Logwood,
$1\frac{3}{4}$ lbs. Nutgalls,
2 lbs. Madder,
2 lbs. Ground Fustic.

Boil wool one and one-half hours.

Sadden with—

1 lb. Alum,
1 lb. Tartar,
2 lbs. Copperas.

Boil one-half hour longer.

Note.—In all cases where all the materials are in a ground state, all the boiling that is required for them before entering the wool, is from twenty to thirty minutes, especially for the light shades, unless otherwise stated in the recipes.

Slate-Drab.

170 lbs. clean Cape Wool.

Prepare with—

$2\frac{1}{2}$ lbs. Chrome,
1 lb. Tartar,
1 lb. Alum.

Finish with—

5 lbs. Logwood,
12 lbs. Madder,
1 lb. Cudbear,
1 lb. Camwood.

Sadden with—

1 lb. Copperas,
1 lb. Tartar.

Boil wool in the preparation, and finish in one and one-half hours each; after saddening, boil one-half hour.

FAWN-DRAB.

300 lbs. Montevideo Wool.

$2\frac{3}{4}$ lbs. Ground Logwood,
3 lbs. Camwood,
9 lbs. Madder.

Sadden with—
3 lbs. Copperas,
$1\frac{1}{2}$ lbs. Alum.

Boil wool one hour before saddening and one hour after saddening.

LIGHT-SLATE DRAB.

200 lbs. Clean Montevideo Wool (or 500 lbs. in the grease).

Prepare with—
2 lbs. Chrome,
1 lb. Alum.

Boil wool one and one-half hours.

Finish with—
4 lbs. Ground Longwood,
2 lbs. Camwood,
1 lb. Cudbear.

Boil one and three-quarters hours.

CLARET.

Second American Fleece, 500 lbs.

Prepare with—
5 lbs. Chrome,
5 lbs. Tartar.

Boil wool one and a half hours.

Finish with—
140 lbs. Camwood,
35 lbs. Hypernic,
12 lbs. Logwood,
20 lbs. Fustic.

Boil wool two hours. Then sadden with eight lbs. copperas, and boil half an hour longer.

Dark Claret.

Second Fleece, 450 lbs.

Prepare with—
6 lbs. Chrome,
7 lbs. Tartar.

Boil one and three-fourths hours.

Finish with—
125 lbs. Camwood,
6 lbs. Logwood,
72 lbs. Hypernic.

Boil wool two hours.

Purple-Claret.

Third Fleece, 300 lbs.

Prepare with—
3 lbs. Chrome,
3 lbs. Alum,
2 lbs. Red Tartar.

Finish with—
90 lbs. Camwood,
6 lbs. Logwood,
20 lbs. Hypernic,
16 lbs. Cudbear.

Sadden with six lbs. copperas.

Boil one and a half hours in preparation, and two hours in the finish, one hour after saddening.

Blues — Indigo Shade (Fast).

Third Australian Wool, 300 lbs.

Prepare with—

12 lbs. Alum,
2 lbs. Tartarine,
2 lbs. Tin Crystals.

Boil the wool three-fourths of an hour. Then draw off.

Finish with—

8 lbs. Chip Logwood.

Boil out the logwood. Then add to the liquor—

18 lbs. Extract of Indigo,
$1\frac{1}{4}$ lbs. Hoffmann's 3 B's Violet.

Boil these for fifteen minutes. Then cool down, and enter the wool. Pole up well, and boil one hour.

Sadden with six lbs. copperas, and boil one half-hour longer.

Note.—When the wool is first entered in the dye, you will see that the logwood is precipitated; but it will all come into solution again after boiling a short time. The cause of its precipitating is the action of the sulphuric acid contained in the chemic, or extract of indigo.

For other recipes for blue, see the recipes with samples.

FRENCH RECIPES.

Swallow Blue.

Cloth, 100 lbs.

Prepare with—

2 lbs. Chrome,
2 lbs. Oxalic Acid,
1 lb. Blue Vitriol,

5 lbs. Alum,
$1\frac{1}{2}$ lbs. Oil of Vitriol.
Boil cloth two hours.

Finish with—
14 lbs. Chip Logwood.
Boil cloth one hour.

RED-BLUE.

Cloth, 50 lbs.

Prepare with—
1 lb. Chrome,
1 lb. Oxalic Acid,
3 lbs. Alum,
$1\frac{1}{4}$ lbs. Tin Crystals,
$\frac{1}{2}$ lb. Cream of Tartar.
Boil cloth two hours.

Finish with—
15 lbs. Logwood,
$7\frac{1}{2}$ lbs. Camwood,
$2\frac{1}{2}$ lbs. Madder,
$\frac{1}{2}$ lb. Tartar.
Boil cloth one and one-fourth hours.

GREEN-BROWN.

Clean Wool, 90 lbs.

Give a light-blue bottom in the blue-vat.

Finish with—
50 lbs. Fustic,
10 lbs. Alum,
1 lb. Tartar.
Boil one and one-half hours. Then

Sadden with six lbs. ground logwood, and boil one half-hour.

N. B.—The wool should be washed after it comes out of the blue-vat.

Yellow-Brown.

Clean Wool, 24 lbs.

4 lbs. Fustic,
2 lbs. Sanders,
1 lb. Sumac.

Boil one and three-fourths hours. Boil wool the same. Then sadden with four ounces copperas, and boil one half-hour longer.

Fast Brown.

Clean Wool, 24 lbs.

6 lbs. Sanders,
2½ lbs. Sumac,
1 lb. Logwood,
2 lbs. Fustic.

Boil dyestuffs and wool one and a half hours. Sadden with—

1 lb. Copperas,
¼ lb. Blue Vitriol.

Boil half an hour.

Gold-Brown.

Clean Wool, 24 lbs.

6 lbs. Fustic,
1 lb. Madder,
1 lb. Sanders,
1 lb. Sumac.

Boil one hour; then add—

$\frac{3}{4}$ lb. Blue Vitriol,
$\frac{1}{2}$ lb. Tartar.

Enter the wool, and boil one and a half hours.

Madder Brown.

Clean Wool, 24 lbs.

Color to a light blue in the blue-vat; then prepare with—

$2\frac{1}{2}$ lbs. Alum,
$\frac{3}{4}$ lb. Red Tartar,
$\frac{1}{4}$ lb. Blue Vitriol,
2 lbs. Fustic.

Boil wool one and a half hours; then

Finish with—

8 lbs. Madder,
$1\frac{1}{2}$ lbs. Sumac.

Boil wool half an hour.

Chrome Brown.

Clean Wool, 24 lbs.

Prepare with—

$\frac{3}{4}$ lb. Chrome,
$\frac{1}{4}$ lb. Blue Vitriol,
$\frac{3}{4}$ lb. Mordant.*

Finish with—

5 lbs. Camwood,
$1\frac{1}{2}$ lbs. Logwood,
1 lb. Fustic.

Boil wool in the preparation one and a half hours, and in the finishing the same time.

* To make the mordant, mix one pound muriatic acid, one pound sulphuric acid, and one pound water. Dissolve in this, twelve pounds feather-tin.

Catechu Brown.

Clean Wool, 24 lbs.

4 lbs. Catechu,
$\frac{1}{2}$ lb. Sal-ammoniac.

Boil wool one and a half hours; then

Finish with—
$\frac{1}{2}$ lb. Chrome.

Boil one hour.

Domingo Brown.

Clean Wool, 24 lbs.

$1\frac{1}{2}$ lbs. Logwood,
2 lbs. Sumac,
2 lbs. Sanders,
1 lb. Fustic.

Boil wool one and a half hours. Also boil the woods the same time. Sadden with—

2 lbs. Copperas.

Boil half an hour.

Maroon.

Clean Wool, 24 lbs.

6 lbs. Camwood,
4 lbs. Urine (sig),
$2\frac{1}{2}$ lbs. Sumac,
2 lbs. Logwood.

Boil the wool two hours.

Sadden with—
2 lbs. Copperas.

Boil half an hour.

Bronze.

Clean Wool, 24 lbs.

6 lbs. Fustic,
$2\frac{1}{2}$ lbs. Camwood,
2 lbs. Sumac.

Boil wool one and a half hours; then

Sadden with—
$\frac{3}{4}$ lb. Copperas,
$\frac{1}{2}$ lb. Blue Vitriol.

Boil half an hour.

Drab.

Clean Wool, 100 lbs.

$2\frac{3}{4}$ lbs. Sanders,
$2\frac{3}{4}$ lbs. Madder,
$\frac{1}{4}$ lb. Sumac,
$\frac{3}{4}$ lb. Fustic.

Boil these one and a half hours; then add—
6 oz. Alum,
$1\frac{1}{4}$ lbs. Tartar.

Enter the wool, and pole up well. Boil for one and three-fourths hours.

Green.

Clean Wool, 100 lbs.

Prepare with—
9 lbs. Alum,
$2\frac{1}{4}$ lbs. Chrome,
$2\frac{1}{4}$ lbs. Oil of Vitriol,
6 oz. Tin Crystals.

Boil wool one and a half hours.

Finish with—

21 lbs. Extract of Indigo,
$\frac{1}{2}$ lb. Extract of Fustic,
$\frac{1}{2}$ lb. Salt.

Boil the wool two hours.

Gold-Olive.

Clean Wool, 100 lbs.

Prepare with—

3 lbs. Chrome,
$1\frac{1}{2}$ lbs. Blue Vitriol,
$\frac{3}{4}$ lb. Oil of Vitriol.

Boil wool one and three-fourths hours.

Finish with—

$5\frac{1}{4}$ lbs. Extract of Fustic,
3 lbs. Camwood,
$\frac{1}{2}$ lb. Extract of Logwood,
3 lbs. Madder.

Boil wool two hours; then

Sadden with—

$\frac{3}{4}$ lb. Copperas.

Boil half an hour.

Chrome Black.

Clean Wool, 100 lbs.

Prepare with—

8 lbs. Alum,
3 lbs. Chrome,
$1\frac{1}{2}$ lbs. Blue Vitriol,
$1\frac{1}{2}$ lbs. Oil of Vitriol.

Boil wool one and a half hours.

Finish with—

8 lbs. Extract of Logwood,
¾ lb. Alum,
¾ lb. Blue Vitriol.

Boil two hours.

This black is more of a blue-black than black. We have worked a greater part of these French recipes, and find them very good indeed.

GERMAN RECIPES.

Black.

100 lbs. Clean Wool.

Prepare with—

3 lbs. Chrome,
3 lbs. Blue Vitriol,
1½ lbs. Oil of Vitriol.

Boil wool one and a half hours.* Leave until next day before finishing.

Finish with—

65 lbs. Chip Logwood.

Boil drugs one and a half hours; boil wool the same; then sadden with—

4 lbs. Blue Vitriol,

and boil half an hour.

Fast Blue-Black.

25 lbs. Clean Wool.

Prepare with—

½ lb. Chrome,
½ lb. Bisulphate Soda,

* The dyestuffs (that is, the woods) in all cases to be boiled one and a half hours; also the wool, unless otherwise specified. By the phrase, leave over night, it is understood that you do not finish off until the next day.

4 oz. Blue Vitriol,
2 oz. Oil of Vitriol.

Finish with—
1 lb. Cutch,
5 lbs. Chip Logwood.

Castor Black.

12 lbs. Clean Wool.

Prepare with—
½ lb. Blue Vitriol,
¼ lb. Tartar,
1¼ lbs. Copperas,
¾ lb. Fustic (Chips).

Boil out the fustic before adding the salts. Boil wool two hours; leave over night.

Finish with—
2¾ lbs. Chip Logwood,
1 drachm Verdigris.

Zinc Black.

10 lbs. Clean Wool.

Prepare with—
½ oz. Blue Vitriol,
½ lb. Zinc Solution,*
¼ lb. Chrome.

Finish with—
2 lbs. Chip Logwood,
¼ lb. Turmeric.

* To make the zinc solution, kill one pound muriatic acid with three ounces of zinc, or in that proportion.

Coal Black.

100 lbs. Cloth.

Prepare with—
15 lbs. Logwood,
15 lbs. Fustic.

Boil these for one and a half hours; then add
10 lbs. Copperas,
3 lbs. Blue Vitriol,
2 lbs. Tartar.
Boil cloth two hours; next day

Finish with—
50 lbs. Chip Logwood.
Boil wood one and a half hours; cloth two hours.

This is the best black that can be made upon cloth, and the most permanent, except indigo black.

Blue-Black.

100 lbs. Cloth.

Prepare with—
$1\frac{1}{2}$ lbs. Copperas,
4 lbs. Blue Vitriol,
1 lb. Alum,
$2\frac{1}{2}$ lbs. Tartar.

Finish with—
40 lbs. Chip Logwood.
Proceed as for the coal black.

Blue-Black.

100 lbs. Clean Wool.

Prepare with—
3 lbs. Chrome,
2 lbs. Salt,

2 lbs. Tin Crystals,
1 lb. Alum,
1 lb. Oil of Vitriol.

Finish with—
40 lbs. Chip Logwood,
1 lb. Chip Fustic.
Boil wool one hour.

Black.

40 lbs. Cloth.

Prepare with—
2 lbs. Sumac,
2 lbs. Fustic,
$\frac{1}{2}$ lb. Madder.

Boil these half an hour; then add
1 lb. Blue Vitriol,
$1\frac{1}{2}$ lbs. Copperas.
Boil the cloth two hours; leave over night.

Finish with—
14 lbs. Chip Logwood.
Boil cloth one hour.

Although this recipe originated in Germany, my father and nearly all the dyers in Yorkshire used it thirty-five years ago, and at that time there was no other black that brought so high a price.

We have ourselves colored by this, and can recommend it as producing a first-rate color. The German recipes produce good clear, bright, and permanent colors; but most of our manufacturers object to them on account of the expense, which is a very foolish objection, in our opinion.

Madder Red.

11 lbs. Cloth.

Prepare with—

2 lbs. Alum,
1 lb. Tartar,
$\frac{1}{2}$ oz. Tin Crystals.

Boil cloth two hours; leave over night.

Finish with—

1 lb. Garancine or Alizorine,
1 lb. Cream of Tartar.

Boil cloth one and a half hours.

Coffee Color.

100 lbs. Clean Wool.

Prepare with—

60 lbs. Red Sanders,
50 lbs. Fustic,
40 lbs. Logwood.

Boil these two hours; boil the wool two hours; then sadden with eleven lbs. copperas and boil one-half hour longer.

Red-Brown.

200 lbs. Clean Wool.

Prepare with—

25 lbs. Alum,
5 lbs. Tartar,
3 lbs. Chrome.

Boil wool one and a half hours.

Finish with—

200 lbs Camwood,
50 lbs. Fustic,
8 lbs. Logwood.

Boil wool two hours; then sadden with six lbs. blue vitriol and boil one-half hour longer.

Catechu Brown.

100 Clean Wool.

20 lbs. Cutch,
2 lbs. Blue Vitriol.

Boil two hours.

Finish with—
4 lbs. Chrome.

Boil one hour.

Cherry-Brown.

200 lbs. Clean Wool.

Prepare with—
25 lbs. Alum,
3 lbs. Chrome,
6 lbs. Tartar.

Finish with—
200 lbs. Camwood,
20 lbs. Fustic,
6 lbs. Logwood.

Boil two hours; then sadden with six lbs. blue vitriol and boil one-half hour.

Brown.

200 lbs. Clean Wool.

Prepare with—
5 lbs. Chrome,
2½ lbs. Blue Vitriol,
4 lbs. Tartar.

Boil wool two hours.

Finish with—
120 lbs. Fustic,
100 lbs. Camwood,
2 lbs. Logwood.

Boil woods two hours; boil wool two hours; then sadden with two and a half lbs. copperas; boil one-half hour and leave it in the liquor for two or three hours. This is a good heavy color and a splendid shade.

Brown.

200 lbs. Clean Wool.

150 lbs. Camwood,
4 lbs. Fustic,
3 lbs. Tartar.

Boil out the woods for two hours, then add the tartar. Boil the wool two hours; then sadden with three lbs. copperas and boil one-half hour longer.

Sanders Brown.

100 lbs. Clean Wool.

35 lbs. Red Sanders,
4 lbs. Fustic.

Boil woods one hour; boil wool the same; then sadden with one lb. blue vitriol and boil three-fourths of an hour.

Brown.

200 lbs. Clean Wool.

Prepare with—

5 lbs. Chrome,
2½ lbs. Oil of Vitriol.

Finish with—

90 lbs. Fustic,
6 lbs. Turmeric,
100 lbs. Camwood,
2 lbs. Logwood.

Boil wool two hours; then sadden with two and a half lbs. copperas and boil one-half hour longer.

Maroon.

100 lbs. Clean Wool.

Prepare with—

2 lbs. Chrome.

Boil wool two hours.

Finish with—

10 lbs. Cudbear,
15 lbs. Hypernic-wood,
30 lbs. Camwood.

Boil one and three-fourths hours.

Maroon.

100 lbs. Clean Wool.

Prepare with—

15 lbs. Alum,
5 lbs. Sulphate of Soda (Glauber Salts).

Finish with—

10 lbs. Hypernic,
40 lbs. Barwood,
4 lbs. Extract of Fustic.

Boil wool one and three-fourths hours.

Maroon.

100 lbs. Clean Wool.

2 lbs. Cudbear,
50 lbs. Camwood,
2 lbs. Logwood.

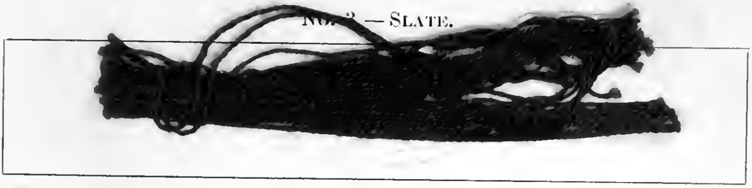
Boil wool two hours; then sadden with two and a half lbs. copperas; boil one-half hour longer.

SAMPLES OF COTTON-YARN.

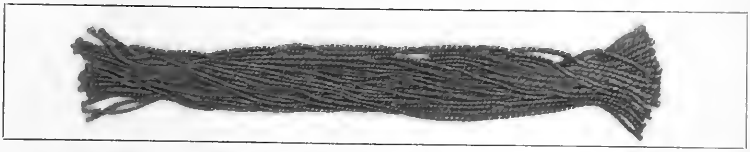
No. 1.—Copperas Brown.

No. 2.—Yellow-Brown.

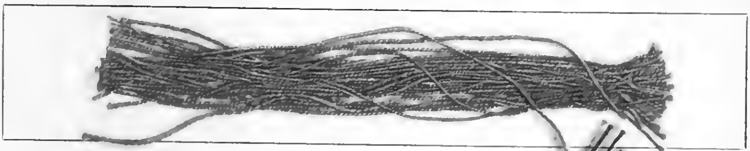
No. 3.—Slate.



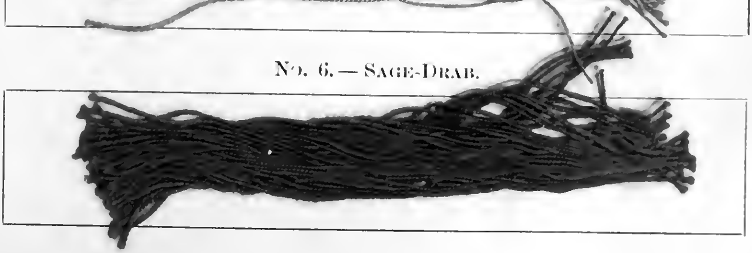
No. 4.



No. 5.—Centennial Drab.

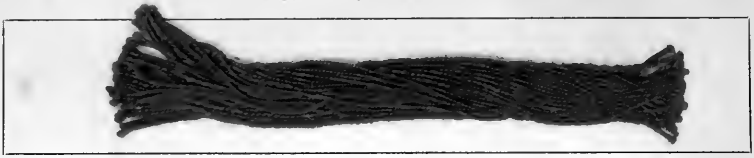


No. 6.—Sage-Drab.

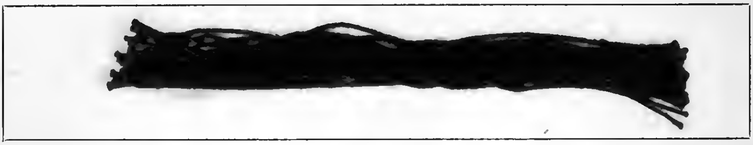


SAMPLES OF COTTON-YARN.

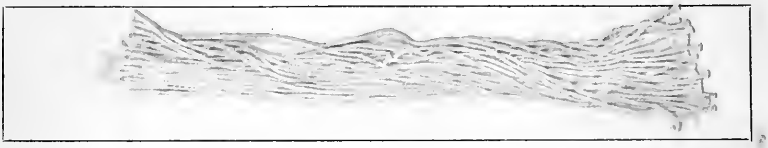
No. 7.—Silver-Drab.



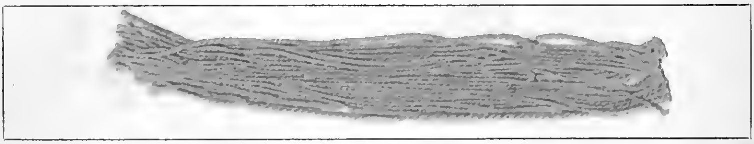
No. 8.—Spirit Brown.



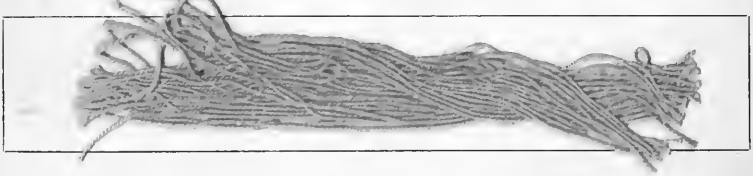
No. 9.—Dark Salmon.



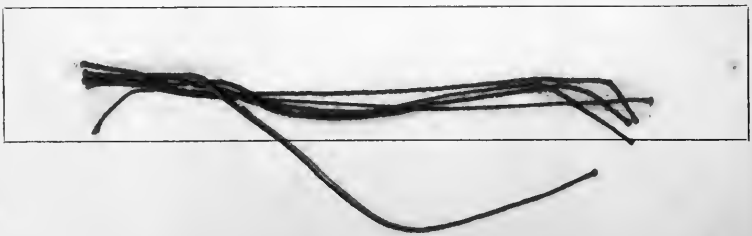
No. 10.—Nankeen.

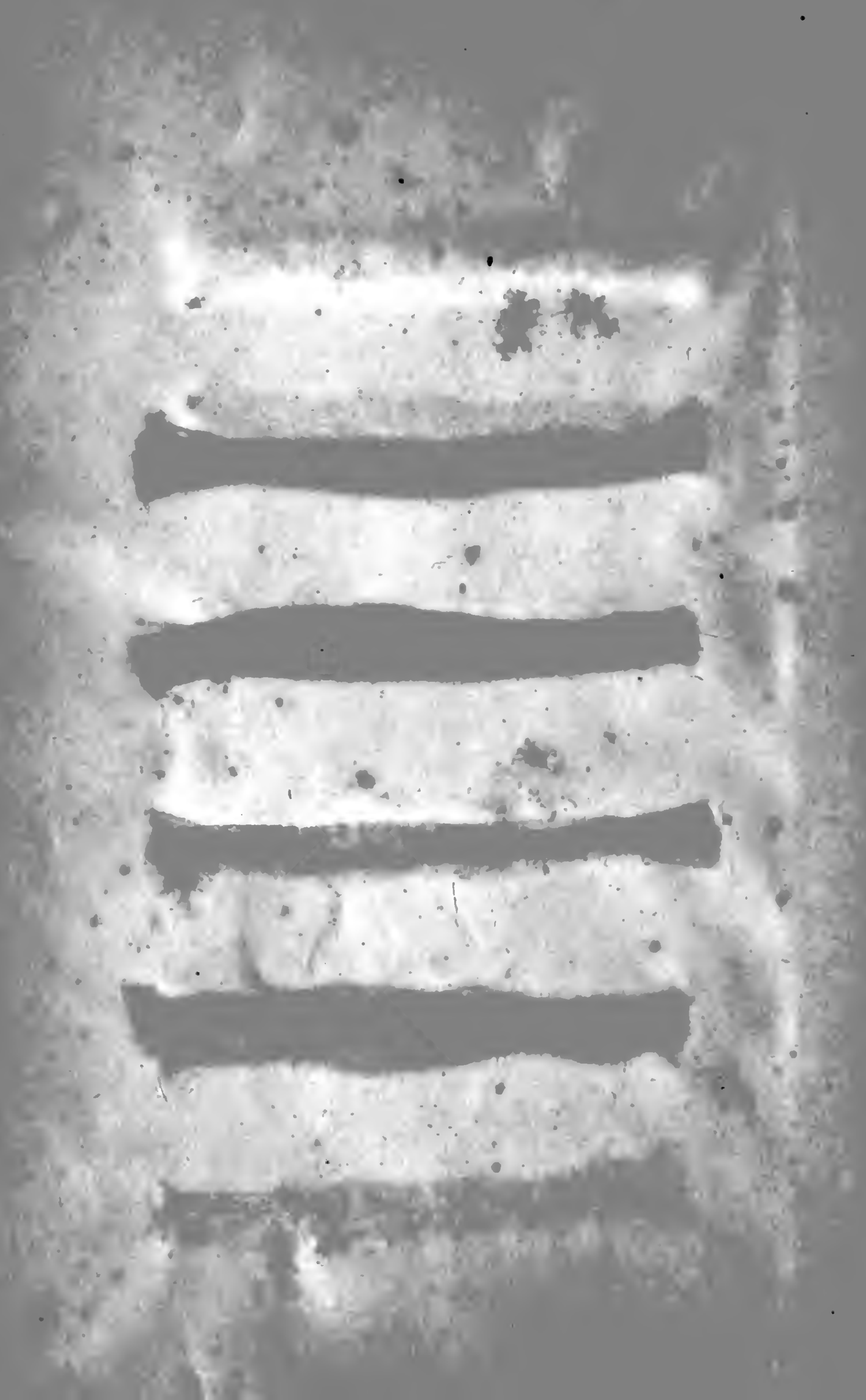


No. 11.—Turmeric Yellow.



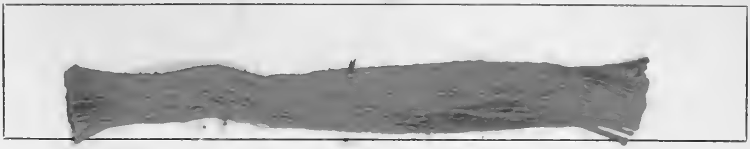
No. 12.—Dark Saffranine.





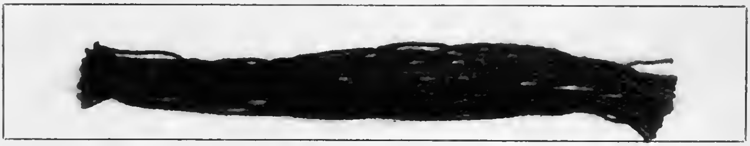
SAMPLES OF COTTON-YARN.

No. 13. — Forget-me-not Orange.



No. 14. — Magenta.

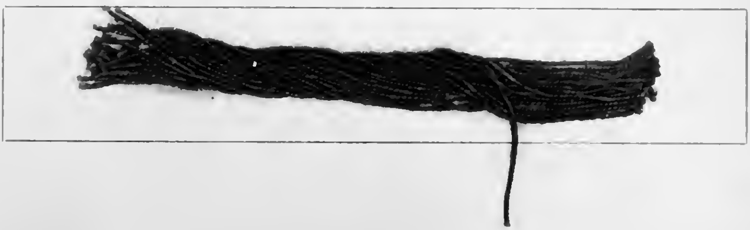
No. 15. — Spirit Purple.



No. 16. — Hoffmann's Violet.

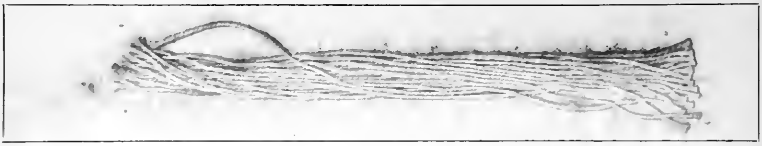
No. 17. — Blue-Violet.

No. 18. — Light Methyl Violet.

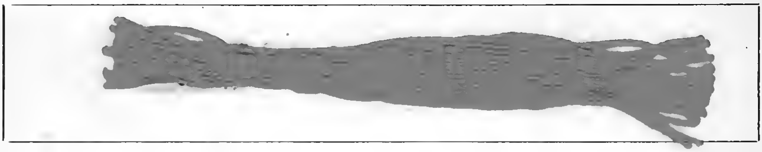


SAMPLES OF COTTON-YARN.

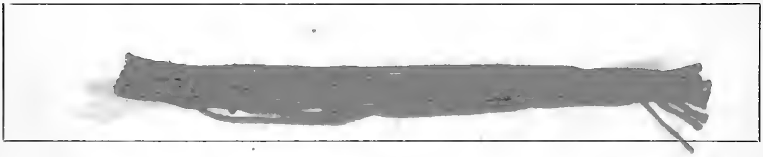
No. 19. — Light Salmon.



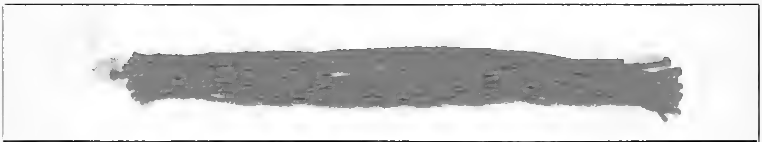
No. 20. — Gold Color.



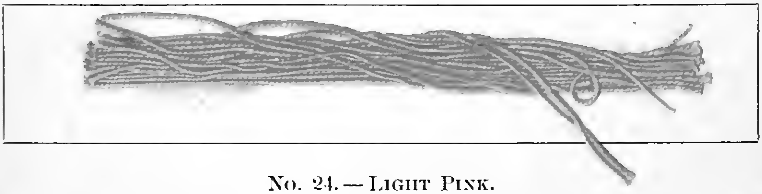
No. 21. — Centennial Salmon.



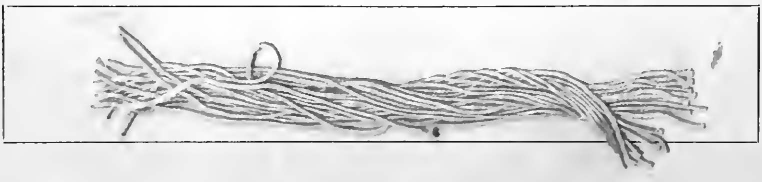
No. 22. — Saffranine Pink.



No. 23. — Dark Pink.



No. 24. — Light Pink.



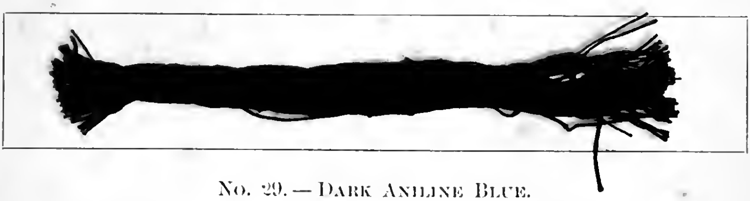
SAMPLES OF COTTON-YARN.

No. 25.—Dark Sage-Drab.

No. 26.—Dark Slate.

No 27.—Prussian Blue.

No. 28.—Light Prussian Blue.

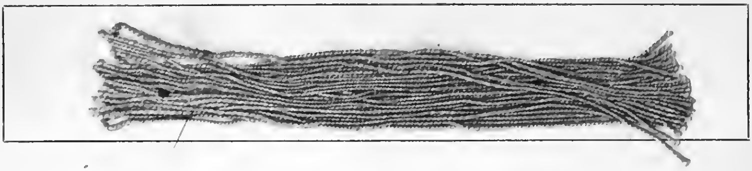


No. 29.—Dark Aniline Blue.

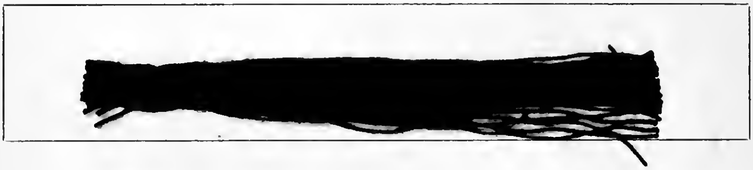
No. 30.—Light Aniline Blue.

SAMPLES OF COTTON-YARN.

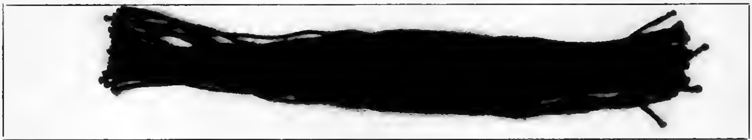
No. 31. — Lavender.



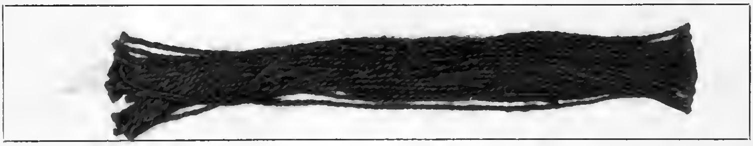
No. 32. — Dark Green-Olive.



No. 33. — Dark Bismarck.



No. 34. — Light Bismarck Brown.



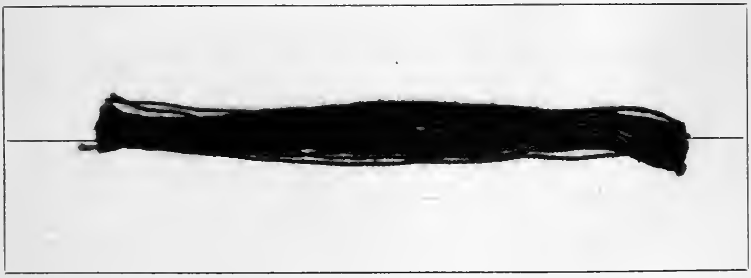
No. 35. — Dark Brown.

No. 36. — Dark Prussiate Green.

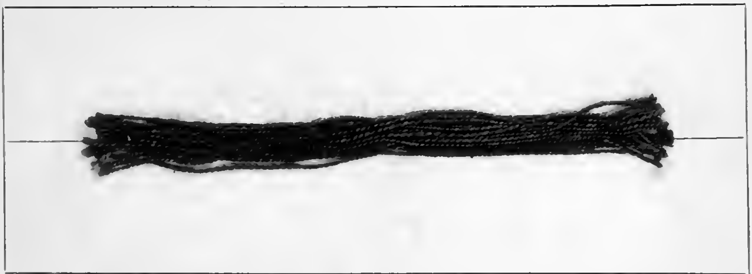
SAMPLES OF COTTON-YARN.

No. 37. — Prussian Green.

No. 38. — Aniline Green.



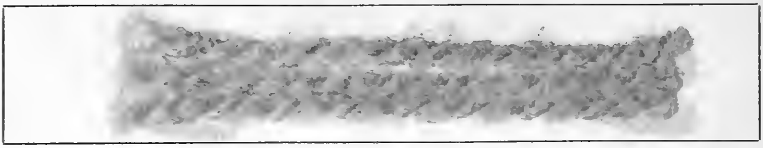
No. 39. — Light Aniline Green.



No. 40. — Red.

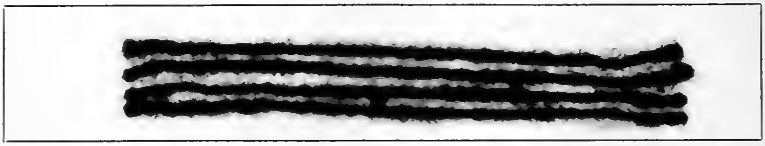
SAMPLES OF WOOLEN-YARN.

No. 1. — Light Blue Stain. (Page 626.)



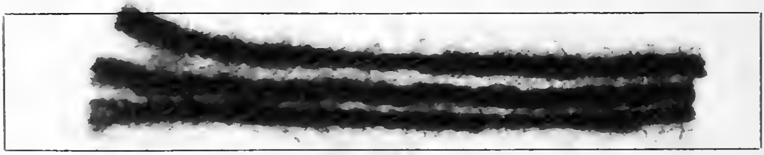
No. 2. — Dark Blue Stain. (Page 627.)

No. 3. — Heavy Royal Blue. (Page 627.)

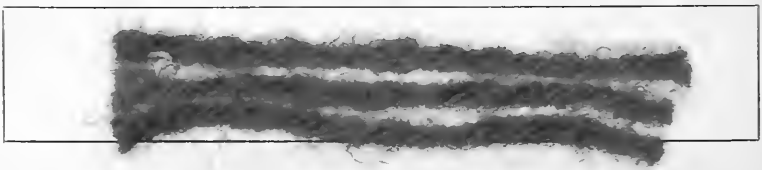


No. 4. — Canary. (Page 627.)

No. 5. — Methyle Green. (Page 628.)



No. 6. — Cardinal-Red. (Page 628.)



REMARKS IN REFERENCE TO THE RECIPES, WITH SAMPLES, ON COTTON-YARN. (See pp. 38, 149.)

These colors were produced from recipes of Mr. Joseph Haywood, who is as proficient in cotton-yarn dyeing as any dyer in the States.

All those colors that are first *sumacked* and then *spirited* are *fast colors*.

Those materials that cannot be entirely dissolved in water must be boiled out first in a separate vessel and allowed to settle, then take the clear solution and add it to the dye-tub. The solutions should always be raked up or stirred up before the yarn is entered. Be sure that the anilines and other crystalline materials are all *thoroughly dissolved* before adding them to the dye-tub.

The anilines used on these yarns were from A. Poirrier of Paris.

The yarn should be washed in cold water, unless otherwise stated, and before it is colored it must be boiled out in soda-ash for three or four hours, then taken and thoroughly washed from the *ash* before it is colored.

Where the recipes say *wring*, they mean wring the yarn on a *pin*, or to use the *extractor* will do as well. The yarn should be boiled in clear water for a few hours before it is colored.

RECIPES FOR COLORS ON COTTON-YARN.

Copperas Brown.

No. 1. Yarn, 40 lbs.

3 lbs Cutch,
2 oz. Copperas.

Steep the yarn in this all night; next morning wring it out. This is a cold bath.

Second bath. Heat to be 110° Fahr.

1 lb. Chrome,

¾ lb. Blue Vitriol.

Enter the yarn and give seven turns, then take out and wash it off.

Finish it in cold lime-water, giving it five turns. Soften it in the oil-wash. (See Oil-wash, page 115.)

Yellow-Drab.

No. 2. Yarn, 33 lbs.

Heat, 100° Fahr.

4 lbs. Fustic,

1 lb. Sumac,

½ lb. Logwood.

Give five turns in this, raise out the yarn, and add to the tub one-half lb. copperas. Re-enter the yarn and give five turns; take out and wash off.

Slate.

No. 3. Yarn, 33 lbs.

Heat, 110° Fahr.

4 lbs. Fustic,

4 lbs. Hypernic,

1 lb. Logwood.

Give seven turns in this; take out; add to tub one-fourth lb. copperas. Re-enter yarn; give five turns; take out and wash off.

Tan.

No. 4. Yarn, 33 lbs.

Heat, 200° Fahr.

3 lbs. Cutch,

6 oz. Blue Vitriol.

Turn yarn for one-half hour; take it out and wring.

Finish in a fresh bath at 200° Fahr., in which use three-fourths lb. Chrome; give five turns in this; take out and wash off.

CENTENNIAL DRAB.

No. 5. Yarn, 33 lbs.

Heat, 110° Fahr.
10 oz. Fustic,
2 oz. Hypernic.

Give five turns; take out and add to the tub one oz. of copperas. Re-enter yarn; give three turns; take out and wash off.

SAGE-DRAB.

No. 6. Yarn, 33 lbs.

Heat, 120° Fahr.
5 lbs. Fustic,
1 lb. Sumac.

Give four turns; take out; add to tub one-half lb. copperas. Re-enter yarn and give four turns. Take out and wash off.

SILVER-DRAB.

No. 7. Yarn, 33 lbs.

Cold bath.
5 oz. Logwood.

Give yarn five turns; take up; add to tub two oz. copperas; re-enter yarn; give three turns; take out and wash off.

SPIRIT-BROWN.

No. 8. Yarn, 33 lbs.

Heat, 200° Fahr.
5 lbs. Sumac.

Turn yarn in this for one-half hour; take out and wring.
Second bath. Cold.
1 pint Nitro-Muriate of Tin.

Give seven turns; take out and wash off, and wring out.

Third bath. Heat, 190° Fahr.

5 lbs. Cutch,

5 oz. Blue Vitriol.

Give seven turns; take out.

Fourth bath. Heat, 190° Fahr.

$1\frac{1}{2}$ lbs. Chrome.

Give yarn five turns in this; take out and wash off.

In order to get a darker shade, you can run it through the second and third baths again.

Dark Salmon.

No. 9. Yarn, 33 lbs.

Heat, 200° Fahr.

2 lbs. Annatto,

1 lb. Soda-ash.

Give yarn five turns; take out.

Second bath. Cold.

1 gill Oil of Vitriol.

Give yarn five turns in this; take out and wash off *well*.

Nankeen.

No. 10. Yarn, 33 lbs.

4 lbs. Copperas.

Give yarn seven turns in this. Wring out the yarn and shake it well; then give it seven turns in cold lime-water.

Soften in cold water to which has been added a few pounds of sal-soda. All these are cold baths.

Turmeric Yellow.

No. 11. Yarn, 33 lbs.

Heat, 200° Fahr.

6 lbs. Turmeric.

Give yarn five turns. Take out.

Second bath. Cold; one-fourth gill oil of vitriol. Enter in this, and give three turns. Take out, and wash off *well*.

Dark Saffranine.

No. 12. Yarn, 33 lbs.

Cold.

5 lbs. Sumac.

Turn yarn in this for half an hour. Take out, and wring it.

Second bath. Cold.

1 pint Nitro-Muriate of Tin.

Give yarn five turns in this. Take out, wash off, and wring the yarn.

Third bath. Heat, 140° Fahr.

2 oz. Golden Roseine,
4 oz. Saffranine.

Give the yarn five turns in this. Take out, and wash off.

Forget-Me-Not Orange.

No. 13. Yarn, 33 lbs.

8 lbs. Brown Sugar of Lead,
3 lbs. Litharge.

Boil these until dissolved. Let it settle. Then add it to a tub of cold water (this is called the lead-tub).

Second tub. Cold, strong lime-water.

Now give seven turns	in the	lime-tub.	Wring out.
"	"	lead-tub.	"
"	"	lime-tub.	"
"	"	lead-tub.	"

Third tub. Cold.

2 lbs. Chrome.

Give yarn seven turns	in the	chrome-tub.	Wring.
"	"	lead-bath.	"
"	"	chrome-tub.	"

Fourth tub. Heat, 200° Fahr.

Strong, clear lime-liquor.

Give yarn three turns in this. Take out, and wash it off. Soften the yarn in the oil-bath. (See Oil-wash, page 115.)

Strong lime liquor or water, is about one degree of strength.

The yarn must be wrung out after each immersion, and well shaken out, before it goes from one tub to the other.

Magenta.

No. 14. Yarn, 33 lbs.

5 lbs. Sumac.

Turn this for half an hour. Wring out the yarn (cold bath).

Second bath. Cold.

$1\frac{1}{4}$ lbs. Stannate of Soda, or

1 lb. Oxy-Muriate of Antimony.

Give five turns in this. Wash off, and wring out.

Third bath. Heat, 120° Fahr.

4 oz. Golden Roseine.

Give seven turns; take out, and wash off quick.

Spirit Purple.

No. 15. Yarn, 33 lbs.

Give yarn seven turns in cold bath, with one pint of muriate of tin. Wash off, and wring out.

Second bath. Heat, 120° Fahr.

12 lbs. Logwood.

Give seven turns. Take out. Add to the tub one lb. of alum. Re-enter the yarn, and give five turns. Take out and wash off.

Hoffmann's Violet.

No. 16. Yarn, 33 lbs.

5 lbs. Sumac.

Turn yarn for half an hour. Take out, and wring the yarn.

Second bath—

3 quarts Red Spirits (see page 377).

Give seven turns in this. Take out, wash off, and wring. The first and second baths are cold ones.

Third bath. Heat, 120° Fahr.

3½ oz. of Hoffmann's 1 B Violet.

Give yarn seven turns in this. Take out, and wash off.

Blue-Violet.

No. 17. Yarn, 33 lbs.

Heat, 200° Fahr.

5 lbs. Sumac.

Turn yarn for half an hour. Take out, and wring.

Second bath. Cold.

1 pint Muriate of Tin.

Give the yarn seven turns. Take out, wash off, and wring the yarn.

Finishing bath. Heat, 120° Fahr.

3 oz. Methyle Violet Crystals.

Give the yarn four turns in this. Take out, and add to the bath one gill of acetic acid. Re-enter the yarn, and give four turns more. Take out, and wash it off.

Light Methyle Violet.

No. 18. Yarn, 33 lbs.

Heat, 130° Fahr.

1¾ oz. Methyle Violet Crystals.

Give five turns. Take out, and wash off.

Light Salmon.

No. 19. Yarn, 33 lbs.

Heat, 200° Fahr.

1 lb. Annatto,

½ lb. Soda-ash.

Give five turns in this. Then take out, and raise the color in a fresh bath of weak lime-water (cold), giving the yarn five turns. Then take out, and wash off.

N. B.—If you wish for a redder shade, heat up the lime-bath a little. The hotter the lime-water is, the redder will be the shade.

Gold Color.

No. 20. Yarn, 33 lbs.

Heat, 200° Fahr.

6 lbs. Sumac.

Turn yarn for half an hour. Take it out, and wring it.

Second bath. Cold.

1 pint Muriate of Tin.

Give seven turns in this. Take out, wash off, and wring out.

Third bath. Heat, 140° Fahr.

2 oz. Phosphine.

Give the yarn six turns. Take out, and wash off.

In finishing in the phosphine, you must enter the yarn in *double-quick time*, and give it a turn as quick as possible, or *otherwise* it will be *uneven*.

Centennial Salmon.

No. 21. Yarn, 33 lbs.

Heat, 200° Fahr.

3 lbs. Turmeric.

Give the yarn five turns. Take out. Then add half a gill of oil of vitriol. Re-enter the yarn, and give five turns more. Take out, and wash off *well*.

Second bath. Heat, 100° Fahr.

1 bottle of Safflower.

Give five turns. Take out, and add one gill of oil of vitriol to the bath. Re-enter the yarn, and give seven turns. Take out, and wash off in two waters, and, to the last water, add half a pound of cream of tartar.

Saffranine Pink.

No. 22. Yarn, 40 lbs.

Cold bath—

5 lbs. Sumac.

Turn yarn for half an hour. Take it out, and wring.

Second bath. Cold.

1 pint Oxymuriate of Antimony.

Give seven turns. Take out, and wash off *well*, and wring.

Third bath. Heat, 110° Fahr.

4 oz. Saffranine.

Give five turns. Take out, and wash off.

Dark Pink.

No. 23. Yarn, 33 lbs.

Heat, 110° Fahr.

1 bottle of Safflower.

Give five turns. Take out, and add one gill of oil of vitriol.

Re-enter the yarn, and give seven turns. Wash off *well*, and wring out.

Blue up the color in cold water, to which add one-quarter lb. cream of tartar, by giving five turns in this bath.

Light Pink.

No. 24. Yarn, 33 lbs.

Heat, 110° Fahr.

½ bottle of Safflower.

Give the yarn five turns. Then take out, and add half a gill of oil of vitriol. Re-enter the yarn, and give seven turns more. Take out, wash off, and wring out.

Blue up the color the same way as No. 23 is done.

Dark Sage–Drab.

No. 25. Yarn, 33 lbs.

Heat, 120° Fahr.

5 lbs. Fustic,
1 lb. Sumac.

Give yarn five turns. Take it out, and add to bath

4 ounces Copperas,
1 gill Nitrate of Iron.

Re-enter the yarn, and give seven turns more. Take out, and wash off.

Dark Slate.

No. 26.

Heat, 100° Fahr.

4 lbs. Fustic,
4 lbs. Hypernic,
2 lbs. Logwood.

Give yarn five turns. Take out and add

½ lb. Copperas,
1 gill Nitrate of Iron.

Re-enter the yarn, and give five turns more. Take out, and wash off.

Prussian Blue.

No. 27. Yarn, 33 lbs.

First bath. Cold.

2 quarts Nitrate of Iron,
1 lb. Tin Crystals.

Give yarn five turns. Take out, and wring it out.

Second bath. Heat, 100° Fahr.

2 lbs. Yellow Prussiate of Potash.

Give yarn five turns. Take out, and add to the tub one pint oil of vitriol. Re-enter, and give five turns. Wring out

now, and enter the yarn into first bath again, and give five turns. Wring it out, and enter into second bath, and give five turns more. Wash off *well.*

Third bath. Heat, 130° Fahr.

4 ounces 2 B's Violet Crystals.

Give yarn ten turns in this. Take out, and wash off.

Light Prussian Blue.

No. 28. Yarn, 33 lbs.

Proceed in the same manner, and with the same materials and amount as for No. 27, only do not use the third or violet bath.

Dark Aniline Blue.

No. 29. Yarn, 33 lbs.

Heat, 140° Fahr.

4 ounces No. 3 Cotton, Blue Aniline (Poirrier's),
2½ lbs. Alum,
5 ounces Tartaric Acid.

Give the yarn seven turns. Take out, and wash off.

Light Aniline Blue.

No. 30. Yarn, 33 lbs.

Heat, 140° Fahr.

2 ounces No. 1 Single Cotton, Blue Aniline (Poirrier's),
5 ounces Tartaric Acid,
2 lbs. Alum.

Give the yarn seven turns in this. Take out, and wash off.

Lavender.

No. 31. Yarn, 33 lbs.

Heat, 110° Fahr.

4 ounces Methyle Violet Crystals.

Give yarn five turns. Take out, and wash off.

Dark Green–Olive.

No. 32. Yarn, 33 lbs.

Cold bath.

2 quarts Nitrate of Iron.

Give five turns. Take out, and wring.

Second bath. Cold.

2 lbs. Yellow Prussiate of Potash.

Give the yarn five turns. Take up the yarn, and add to the bath one pint oil of vitriol. Re-enter the yarn, and give three turns more. Take it out and wring it, and then pass it through each bath again, without adding any more materials. After passing the yarn through the baths the second time, wash the yarn off, and wring it out for the third bath.

Third bath. Cold.

Take the clear liquor from fifteen pounds fustic, and put it into a tub of cold water. Enter the yarn, and give seven turns. Take it out, and add to the bath one pound blue vitriol. Re-enter the yarn, and give five turns. Take out, and wash off.

Dark Bismarck.

No. 33. Yarn, 33 lbs.

Heat, 190° Fahr.

6 lbs. Cutch.

Give seven turns. Take out.

Second bath. Heat. 190° Fahr.

1 lb. Chrome.

Give seven turns. Pass the yarn through each bath again, as in No. 32.

Third bath. Heat, 120° Fahr.

3 ounces Bismarck-Brown Aniline. Give yarn five turns. Take out, and wash off.

Light Bismarck–Brown.

No. 34. Yarn, 33 lbs.

Heat, 200° Fahr.
3 lbs. Turmeric.
Give five turns, and wring out yarn.
Second bath. Heat, 140° Fahr.
2 ounces Bismarck-Brown Aniline.
Give five turns in this. Take out, and wash off.

Dark Brown.

No. 35. Yarn, 33 lbs.

Heat, 190° Fahr.
7 lb. Cutch,
10 ounces Blue Vitriol.
Give yarn seven turns. Take out, and wring out.
Second bath. Heat, 180° Fahr.
1½ lbs. Chrome.

Give yarn seven turns. Take out and wring. Now repeat, through each bath again, as for No. 33, and wash off yarn.

Dark Prussian Green.

No. 36. Yarn, 33 lbs.

Heat, 200° Fahr.
6 lbs. Sumac.
After giving seven turns, lay the yarn under the liquor for a few hours, or over night. Take out, and wring the yarn.
Second bath. Cold.
1 quart Nitrate of Iron.
Give yarn five turns. Take out, and wring out.
Third bath. Cold.
1½ lbs. Yellow Prussiate Potash.

Give yarn five turns. Take up, and add to the bath one gill oil of vitriol. Re-enter the yarn, and give two turns more. Take out, wash off, and wring out.

Third bath. Heat, 180° Fahr.

1 lb. Turmeric.

6 lbs. Fustic.

Give yarn seven turns. Take out, and wash off.

Prussian Green.

No. 37. Yarn, 33 lbs.

Proceed for the two first baths precisely as for No. 36.

Third bath.

3 lbs. Turmeric.

Give five turns. Take up the yarn, and add to the tub one-half gill oil of vitriol. Re-enter yarn, and give five turns. Take out, and wash off. (These are all to be cold baths.)

Aniline Green.

No. 38. Yarn, 33 lbs.

Heat, 200° Fahr.

5 lbs. Sumac.

Turn the yarn for one-half hour. Take out, and wring out.

Second bath. Cold.

1 pint Muriate of Tin.

Give seven turns, and wring out.

Third bath. Heat, 135° Fahr.

3 ounces Methyle-Green Aniline (marked JJ).

Give yarn seven turns. Take out, and wring out.

Fourth bath. Heat, 110° Fahr.

10 lbs. Fustic.

Give five turns. Take up, and then add one pound alum. Re-enter, and give five turns more. Take out, and wash off.

If you prefer it, you can use the fustic in the same bath, along with the methyle aniline; but by so doing, the color is not quite so clear.

Light Aniline Green.

No. 39. 33 lbs. Yarn.

Heat, 200° Fahr.
4 lbs. Sumac.
Turn the yarn for half an hour; take out and wring.

Second bath. Cold.
1 pint Muriate of Tin.
Give seven turns; take out, wash off, and wring out.

Third bath. Heat, 110° Fahr.
2 oz. Methyle Green.
The same as used in No. 38. Give seven turns; take out, and wring out.

Fourth bath. Heat, 110° Fahr.
7 lbs. Fustic.
Give five turns; take up, and add to the bath half a pound of alum; re-enter the yarn, and give three turns; take out, and wash off.

Red.

No. 40. 33 lbs Yarn.

Heat, 150° Fahr.
3 lbs. Sumac,
1 quart Muriate of Tin.
Use these together in same bath. Give yarn ten turns; take out, and wash off *well*.

Second bath. Heat, 150° Fahr.
10 lbs. Hypernic,
2 oz. Roseine,
2 lbs. Alum.
Give yarn seven turns; take out, and wash off.

REMARKS ON WOOLEN-YARN DYEING.

In the first place, be particular to have the yarn well *scoured*, and thoroughly washed out. Next, after being washed in cold water, wash it off again in a warm acidulated water, which will kill any soap that may be left from the cold-water washing. Scour the yarn with soap and sal-soda (no soda-ash).

In entering the yarn into the different tubs do it *expeditiously*, so that it all may take the dye very nearly at one time. Have everything clean about the tubs, and around them, so that there will be no chance of spotting the yarn.

Before entering the yarn into the tubs, rake or stir up the dyeing solutions.

The extract of indigo used on these recipes was made by using six pounds of oil of vitriol to one pound of ground indigo. See article, Sulphate of Indigo, for the manner of mixing them, &c.

In dyeing to a pattern, begin with little enough dye-stuff, as, if it does not come full enough, you can add more; but if you give too much, you cannot remedy the bad result.

RECIPES FOR WOOLEN-YARN.

Light Blue Stain.

No. 1. Three-fold Yarn, 50 lbs.

1 oz. Nicholson 6 B's Fast Blue,
3 oz. Sal-soda.

Enter the yarn at 120° Fahr.; give nine turns; take out, and raise the heat to the boiling point. Re-enter the yarn, and give nine turns more; take out.

*Develop at 120° Fahr. heat.

1 quart Oil of Vitriol.

Give yarn five turns; take out, and wash off.

* Develop in a tub of clean water, and have the tub well cleaned from a previous color.

Dark Blue Stain.

No. 2. Three-fold Yarn, 55 lbs.

Prepare with—

$1\frac{3}{4}$ oz. Nicholson 6 B's Fast Blue,
3 oz. Sal-soda.

Proceed as for light blue stain.
Develop with—

3 pints Oil of Vitriol, at 120° Fahr. heat.

Give five turns; take out, and wash off.

Heavy Shade of Royal Blue.

No. 3. Three-fold Yarn, 60 lbs.

20 lbs. Extract Indigo (thin),
4 oz. best Golden Roseine,
2 quarts Oil of Vitriol.

Enter cool; give yarn nine turns; take it out, and raise the heat to 200° Fahr. Re-enter the yarn, and give nine turns more.

Note.—The extract of indigo used for this color was made with six pounds of oil of vitriol to one pound of ground indigo. See article, Sulphate of Indigo, for instructions how to mix it.

Canary Color.

No. 4. Six-Thread Woolen-Yarn, 5 lbs.

3 oz. Flavine,
$3\frac{1}{2}$ oz. White Tartar,
3 gills Muriate of Tin.

Cool down the bath; enter the yarn and turn for one-half hour; then take out the yarn and bring the heat up to the boiling-point; add one more gill of muriate of tin; re-enter the yarn and turn to shade; then wash it off and dry. This is a beautiful shade.

METHYLE GREEN.

No. 5. Three-fold Yarn (coarse), 60 lbs.

Dissolve seven ounces methyle-green crystals in a pail of water; pour one-third into a tub of water at 130° Fahr.; rake up well, enter yarn, and give seven turns; take it out and heat up to 170° Fahr.; put in one-third more of the dissolved crystals, rake up, re-enter yarn again, give seven ends more, take out the yarn again, and raise the heat to 200° Fahr. Pour in the remainder of the methyle crystals, rake up, and re-enter the yarn; give seven turns, take out and air.

Now in a tub of fresh cold water, put half a pound picric acid and two quarts oil of vitriol (be sure that the picric acid is all dissolved). Enter the yarn at a "*double quick*," give it a few lively turns, then turn for three-fourths of an hour; take out and wash off.

This is a very difficult color to get even, so you must handle it *very quick* at first, especially in the picric-acid bath.

CARDINAL-RED.

No. 6. Three-fold Yarn (coarse), 60 lbs.

8 oz. Cardinal Aniline,
1 oz. Martius Yellow.

Enter yarn at 190° Fahr., give nine turns. Take out, raise the heat to boiling-point, and add six ounces more of cardinal aniline. Rake up well, re-enter yarn, and give nine turns; take out and wash off.

For next sixty pounds, in same liquor, use one ounce Martius yellow, and twelve ounces cardinal aniline; use the aniline twice, as for first lot, and proceed the same.

MEDIUM BLUE.

Three-fold Yarn, 100 lbs.

4 lbs. Nicholson's B Blue,
6 lbs. Sal-soda.

Give nine turns; take up, and raise the heat to 200° Fahr. Re-enter the yarn, and give five turns more; take out, and wash off.

In another tub of water, at 140° Fahr., put

$2\frac{3}{4}$ lbs. Yellow Prussiate of Potash,
6 lbs. Oil of Vitriol.

Enter yarn and give five turns; take out, raise the heat to 170° Fahr. Re-enter the yarn; give five turns more; take out, raise to the boiling-point. Re-enter yarn; give seven turns more; take out, and wash off.

For the next one hundred pounds of yarn, add to the first tub—

$1\frac{1}{2}$ lbs. Nicholson B Blue,
3 lbs. Sal-soda.

Enter, and proceed as for the first one hundred pounds.

The second, or finishing tub, must always be a fresh one, as the prussiate will be all taken up, and the result will not be satisfactory, if you should try to use it again by adding more prussiate.

Dark Nicholson Blue.

Four-fold Yarn, 50 lbs.

Prepare with—

$\frac{3}{4}$ lb. Nicholson 2 B's Blue,
$1\frac{1}{2}$ lbs. Borax.

Add the borax to the bath first, then the dye. Enter at 120° Fahr. Give nine turns; take out the yarn, and raise the heat to boiling-point. Re-enter the yarn, and give nine turns more; take out, and

Develop at 120° Fahr.

3 pints Oil of Vitriol.

Give the yarn five turns; take out, and wash off.

Light Nicholson Blue.

Four-fold Yarn, 50 lbs.

2 oz. Nicholson 2 B's Blue,
½ lb. Borax.

Proceed as for dark Nicholson blue, and develop the same as for the dark color.

These five shades of aniline blue are all the style just now (April, 1878).

Orange.

Two-fold Yarn, 50 lbs.

¾ lb. Cochineal,
15 oz. Flavine,
½ lb. Oxalic Acid,
1 lb. White Tartar,
1 quart Muriate of Tin.

Enter yarn at 160° Fahr., give nine turns; take it out; raise the heat to boiling-point. Re-enter yarn and give nine turns more; take out and wash off.

Light Orange.

Single-run Yarn, 40 lbs. Size six runs.

Prepare with—

5 lbs. Alum,
3 lbs. Tartar,
6 oz. Flavine,
1 oz. Cochineal,
6 gills Scarlet Spirits,
6 gills Yellow Spirits.

Proceed as for the above orange.

Orange.

Single-run Worsted Yarn, 40 lbs.

1 lb. Flavine,
¾ lb. Cochineal,

2 lbs. Tartar,
8 gills Scarlet Spirits,
8 gills Yellow Spirits.

Enter yarn and proceed as for the above oranges.

Salmon Color.

Two-fold Yarn, 35 lbs.

5 oz. Cochineal,
1 oz. Flavine (short-weight),
1 lb. Tartar,
1 quart Muriate of Tin.

Enter the yarn, cool, give seven turns; take it out, raise the heat to a boil. Re-enter yarn, give seven turns more, take out and wash off.

Chrome Brown.

Two-fold Yarn, 50 lbs.

Prepare with—

1¾ lbs. Chrome,
1 lb. Alum,
¾ lb. Tartar.

Enter yarn at 180° Fahr., give nine turns; take it out, raise the heat to a boil. Re-enter the yarn and turn for three-fourths of an hour; take out.

Finish with—

5 lbs. Madder,
10 lbs. Camwood,
5¾ lbs. Ground Fustic,
6 oz. Brazil-wood,
5 oz. Logwood.

Boil these one hour. Enter as for the preparation, and proceed the same way.

Dark Brown.

Two-fold Yarn, 35 lbs.

Prepare with—

$1\frac{1}{4}$ lbs. Chrome,

$\frac{1}{2}$ lb. Alum.

Finish with—

3 lbs. Madder,

3 lbs. Fustic,

$3\frac{1}{2}$ lbs. Brazil-wood,

12 lbs. Camwood,

4 oz. Logwood.

Proceed in all respects as for chrome brown.

Light Cinnamon-Brown.

Two-fold Yarn, 35 lbs.

Prepare with—

1 lb. Chrome,

6 oz. Alum.

Finish with—

$2\frac{3}{4}$ lbs. Fustic,

$4\frac{3}{4}$ lbs. Brazil-wood,

6 lbs. Camwood,

5 lbs. Barwood,

3 oz. Logwood.

Proceed as for the chrome brown.

Purple.

Jacket Yarn, 50 lbs.

15 lbs. Cudbear,

$\frac{1}{2}$ lb. Roseine,

$\frac{1}{2}$ lb. Picric Acid,

9 lbs. Extract of Indigo.

Boil these for fifteen minutes; then add—

3 quarts Oil of Vitriol,

15 lbs. Glauber Salts,

10 lbs. Alum.

Cool down, and rake up well. Enter the yarn, give nine turns; take it out, and raise the heat to a boil. Re-enter the yarn, and give nine turns, or turn until the shade suits you.

Light Slate.

Twofold Yarn, 35 lbs.

$1\frac{3}{4}$ lbs. Ground Logwood,
$1\frac{1}{4}$ lbs. Ground Fustic,
10 oz. Sumac.

Boil these twenty minutes; then add—

8 oz. Alum,
9 oz. Extract of Indigo.

Rake up well; cool down. Enter yarn, and proceed as for purple.

Silver-Drab.

Twofold Yarn, 50 lbs.

18 oz. Madder,
13 oz. Barwood,
10 oz. Ground Logwood,
10 oz. Sumac,
5 oz. Nutgalls,
4 oz. Cudbear.

Boil these for twenty-five minutes. Cool down, and enter yarn; give seven turns; take out, raise the heat to a boiling point. Re-enter yarn, give seven turns; take out yarn, and add to the tub—

2 oz. Copperas.

Rake up and re-enter the yarn, and give five turns; take out and wash off.

Yellow-Drab.

Threefold Yarn, 35 lbs.

$\frac{3}{4}$ lb. Chrome,
3 oz. Alum,
3 oz. Tartar.

Proceed as for the browns.

Finish with—

$1\frac{1}{4}$ lbs. Camwood,
1 lb. Madder,
13 oz. Ground Fustic.

Proceed as for brown.

Slate-Drab.

Threefold Yarn, 50 lbs.

$4\frac{1}{2}$ lbs. Ground Logwood,
2 lbs. Barwood,
$1\frac{3}{4}$ lbs. Madder,
7 oz. Ground Fustic,
12 oz. Sumac.

Boil these for twenty-five minutes, then cool down and add five ounces alum. Enter the yarn, and give seven turns; take it up, and raise the heat to the boil; add six ounces more of alum; rake up, and enter the yarn; give nine turns; take it out and wash off.

Blue-Violet.

Threefold Yarn, 40 lbs.

Dissolve two and a half ounces Hoffmann's 2 B's violet, and half an ounce of golden roseine together, in some convenient vessel. Pour one-half of this into a tub of clean water, heated to 150° Fahr. Rake up well, enter the yarn, give seven turns, take out the yarn, heat up the tub to 200° Fahr. Add the rest of the dissolved anilines; rake up, enter the yarn; give nine turns more, take out and wash off.

Light Red-Violet.

Threefold Yarn, 40 lbs.

1 oz. Hoffmann's 2 B's violet,
$1\frac{1}{2}$ oz. Roseine Crystals.

Proceed as for the blue-violet in all respects.

GREEN.

Threefold Yarn, 25 lbs.

$2\frac{3}{4}$ lbs. Extract of Indigo, *good*,
1 lb. Alum.

Enter yarn at 170° Fahr.; turn it until it becomes even; then take it out and add—

$6\frac{1}{4}$ oz. Picric Acid,
$\frac{1}{2}$ pint Oil of Vitriol.

Rake up well, re-enter the yarn, and give five turns more. Take out *quickly*, and wash off. After giving five turns, if it is not as dark as you wish, give it a few turns more before taking it out.

ANOTHER CARDINAL.

Threefold Yarn, 50 lbs.

4 oz. Flavine,
8 oz. Roseine.

Enter yarn at 170° Fahr, give seven turns, raise out the yarn, heat up to boiling-point. Re-enter yarn, give seven turns more; take out and wash off.

If the color should be too red when finished, add two or three ounces more flavine, and put the yarn in again, and give a few more turns.

A LIGHT BLUE-GREEN.

Single Yarn size, $8\frac{1}{2}$ runs, 40 lbs.

$2\frac{1}{4}$ lbs. Indigo Paste,
$1\frac{1}{2}$ oz. Picric Acid,
12 lbs. Alum.

Enter cool, give seven turns, take up, raise the heat to 200° Fahr. Re-enter the yarn, and give seven turns more; take out, and in a fresh bath at 120° Fahr., put one pint oil of vitriol, enter yarn, give five turns; take out and wash off.

Green.

Twofold Worsted Yarn, 10 lbs.

2 oz. Iodine Green Crystals.

Enter yarn cold. Proceed as for the threefold yarn green. In the finishing bath use—

$1\frac{1}{2}$ oz. Picric Acid,
1 gill Oil of Vitriol.

On this and the methyle green you must *be sure* to *follow* the way laid down in regard to the *manupulations*, or the result will not be satisfactory.

These greens can be varied either to the blue or greener shade, by using more or less picric acid in the finishing bath.

Canary (a splendid shade).

Threefold Yarn (coarse), 5 lbs.

3 oz. Flavine,
$3\frac{1}{2}$ oz. White Tartar,
3 gills Muriate of Tin.

Enter cool. Turn yarn for half an hour; take out, raise the heat to boiling-point. Re-enter the yarn, and turn for twenty minutes longer; take out, and wash off.

Light Bluish-Drab.

Single Yarn, 20 lbs. Size, 7 runs.

Prepare with—

$2\frac{1}{2}$ lbs. Alum,
$1\frac{1}{4}$ lbs. Tartar,
4 oz. Extract Indigo,
2 oz. Ground Fustic,
$1\frac{1}{4}$ lbs. Madder.

Enter yarn at 190° Fahr. Turn for ten minutes. Turn on the steam, and turn until it comes to a boil; then take out, and wash off.

Light Reddish-Drab.

Single Yarn, 40 lbs. Size, 7 runs.

4 oz. Extract Indigo,
$\frac{3}{4}$ lb. Cochineal,
2 lbs. Ground Fustic,
2 lbs. Alum,
2 lbs. Tartar.

Proceed in all respects as for the light bluish-drab.

Scarlet.

Twofold Worsted Yarn, 40 lbs.

Dissolve nine and a half ounces of luteciene in boiling water, and one pound tartaric acid. Enter the yarn at 150° Fahr. (using one-third of the acid and lueticene); give the yarn five turns; take it out; raise the heat to the boil, put in the remainder of the acid and luteciene, rake up well, re-enter the yarn, and turn for twenty minutes longer; take out, and wash off.

Scarlet.

Threefold Yarn, 100 lbs.

10 lbs. Lac Dye,
3 lbs. Cochineal,
2 lbs. Tartar,
1 lb. Oxalic Acid,
10 lbs. Scarlet Spirits.

Boil these for twenty minutes, then cool down. Enter the yarn, and give seven turns; take it out, raise the heat to boil, re-enter the yarn, and give seven turns more; take out, and wash off.

REMARKS ON COTTON-WASTE DYEING.

Having colored with these recipes for some time, and given the preference to them above all others, on account of their certainty and effectiveness, they can be fully relied upon for the accuracy of their results. You will find observations attached to such of them as will require any deviation from the usual way or mode of dyeing.

In making up the liquors according to the recipes, care must at all times be taken to have all the solutions, when ready for the cotton, free from all ground or chipped dyestuffs and all undissolved coloring-matters. The liquors must be clear, and all the solutions of the bath held in solution. If you have to use sumac, or any ground dyestuffs; boil them out in a barrel, or some convenient vessel, and add the clear solutions to the dyeing-bath. But it is more convenient to use the extracts, as they contain more *tannin*, or astringent principle (than the rough dyestuffs), which has a great affinity for cotton. In using the extracts, you can keep the dyeing liquors at about the same strength, and for a long time, by fishing out the cotton from the tub after each dip.

Black (at one operation).

No. 1. Raw Cotton, 100 lbs.

100 lbs. Chip Logwood,
12 lbs. Cutch,
25 lbs. Extract of Logwood.

Boil those one hour; then add to it one pint ammonia FFF. Boil one-half hour longer; take out the bags and add—

5 pints Ammonia,
5 pints Nitrate of Copper.

Rake up the tub; enter cotton as expeditiously as possible; pole up for a few minutes; then boil gently for two hours; leave the cotton in until next morning; fish it out and cover up with sheets until the next day; then wash off.

COTTON SAMPLE.

No. 1. — Black, at one operation.

To renew for next 100 lbs. Cotton.

75 lbs. Chip Logwood,
10 lbs. Cutch,
22 lbs. Extract of Logwood.

1 pint Ammonia.

4 pints Ammonia,
4 pints of Nitrate of Copper.

Proceed as for first 100 lbs. in all respects.

For third or standard recipe. Cotton, 100 lbs.

25 lbs. Chip Logwood,
8 lbs. Cutch,
24 lbs. Extract of Logwood,

½ pint Ammonia.

4 pints Ammonia,
4 pints Nitrate of Copper.

Proceed as for first 100 lbs. cotton.

This black you will see is done at one dip and will resist the fulling and scouring as well as black wool. If a blue-black is wanted use—

5 lbs. Extract of Hemlock,
5 lbs. Extract of Logwood.

Take out.

To make the Nitrate of Copper.

To every pound of nitric acid, 40° Fahr., use three ounces copper-scraps or turnings; add it to the acid very *gradually*.

Or thus—

12 lbs. Nitric Acid, at 40° Twaddle,
2¼ lbs. Copper Scraps.

Kill as above.

The *copper* must be perfectly *free* from *tin* or *solder*.

When the cotton is taken out it will be brown-colored, but will turn to black after being covered up a while. Should the cotton, when dry, have a purple shade, it will do no harm as it will full to a jet-black; but when this is the case reduce the dyestuff a little for one or two lots, and especially the ammonia. After coloring four or five lots, you can then color one hundred and twenty five pounds of cotton at a time with the same amount of dyestuffs.

RECIPES FOR COLORING COTTON OR COTTON-WASTE.

Blacks.

Blacks and browns are the most common colors put upon cotton-waste.

Black.

Cotton, 200 lbs.

45 lbs. Catechu or Cutch,
25 lbs. Extract of Logwood,
10 lbs. Blue Vitriol.

Boil these materials until dissolved. Shake up the cotton and enter it at a boil and pole up well: let it boil gently for one hour; leave it in the tub all night; in the morning fish the cotton out. Then strengthen the liquor with—

50 lbs. Extract of Logwood,
7 lbs. Soda-ash,
3 lbs. Blue Vitriol.

When these are dissolved and the foaming of the liquor has ceased, enter the cotton again and boil for one-half hour, leaving it in the solution all night. In the morning, fish out and wash off the cotton.

The above quantities of materials are for starting a new dye, or for the first two hundred pounds of cotton.

For the second two hundred pounds of cotton, add to the above liquor—

15 lbs. Cutch,
7 lbs. Extract of Logwood,
3 lbs. Blue Vitriol.

Black.

Cotton, 300 lbs.

300 lbs. Chip Logwood,
30 lbs. Chip Fustic.

Boil these woods out. Take out the bags, and add to the liquor fifteen lbs. blue vitriol, ten lbs. brown sugar of lead. When they are dissolved, enter the cotton, and boil it two hours. Fish out the cotton. Then add to the liquor, ten lbs. blue vitriol, fifteen lbs. soda ash. Enter the cotton at 150° Fahr. Pole up well, each time. Leave the cotton in all night. By this method we can color three hundred lbs. per day, by preparing (giving one dip in the forenoon) in the forenoon, and finishing in the afternoon. The cotton, by coloring in this manner, comes out with a brownish shade; but when it is scoured it turns to a jet black. For the second three hundred lbs., in the same liquor, add two hundred and fifty lbs. chip logwood, and twenty-five lbs. chip fustic. Boil out as for first time, and add ten lbs. blue vitriol, and eight lbs. sugar of lead. For the second dip for the second three hundred lbs. cotton, add eight lbs. blue vitriol, and twelve lbs. soda-ash. Proceed as above in all respects. The longer this solution is used, the better is the color. It is the best black produced by any similar method.

Proceed as before. Then add to the liquor—

25 lbs. Extract of Logwood,
4 lbs. Soda-ash,
2 lbs. Blue Vitriol.

Re-enter the cotton as before. Let it stay in all night, and proceed in after-dyeings with the same amount of cotton and

ingredients. The solution, in each instance, should be of a bluish-red purple when the cotton is to be entered the second time. The color of the cotton may not be as deep as desired in the first tubful, but the liquor will improve by age, and will give you colors that will be satisfactory after the second two hundred pounds. Wash off the cotton always after being finished, but give air and all the time you can spare before washing off.

Black.

This is a good and cheap black for jeans.

Cotton, 125 lbs.

Prepare with—

3 lbs. Chrome,
3 lbs. Blue Vitriol.

Enter cotton, and boil one hour. Draw off, and extract the cotton. Then finish with—

50 lbs. Chip Logwood,
15 lbs. Extract of Logwood,
15 lbs. Chip Fustic,
2 lbs. Soda-ash,
2 lbs. Palm Oil.

Boil out the woods. Then add the oil and soda-ash. Then enter the cotton, pole up well, and boil one hour. Leave it in as long as possible.

Black.

Cotton, 225 lbs.

Tannin Process.

6 lbs. Extract of Fustic,
25 lbs. Cutch,
5 lbs. Blue Vitriol.

Dissolve all together. Enter the cotton. Boil one hour. Leave in all night. In the morning, take out, and drain or extract the cotton thoroughly. Save this liquor for further use.

Mordant Process.

8 lbs. Chrome,
8 lbs. Blue Vitriol.

Enter the cotton at a boiling heat. Let it remain in this mordant two or three hours; do not boil in the mordant. Extract the cotton, and shake it up well.

Dyeing Process.

30 lbs. Extract of Logwood,
2 lbs. Extract of Fustic,
3 lbs. Blue Vitriol.

Enter the cotton quickly; pole up well; boil half an hour, and let it remain in the liquor as long as possible.

This is the softest and most permanent black on raw cotton that can be dyed.

For the next two hundred and twenty-five lbs. of cotton, add to the tannin liquor—

4 lbs. Extract of Fustic,
18 lbs. Cutch,
2½ lbs. Blue Vitriol,

and proceed with the mordant and dyeing process as above.

Black.

Cotton, 300 lbs.

50 lbs. Extract of Logwood,
30 lbs. Cutch,
10 lbs. Brown Sugar of Lead,
10 lbs. Blue Vitriol.

Enter the cotton at a boil, pole up well, and boil one and a half hours; leave it in over night. Next morning fish out; then add to the liquor—

15 lbs. Blue Vitriol,
15 lbs. Soda-ash.

Enter the cotton at a boil, pole up well, and let it remain in as long as possible.

For the next three hundred pounds cotton, add to the tub—
40 lbs. Extract Logwood,
25 lbs. Cutch,
8 lbs. Brown Sugar of Lead,
8 lbs. Blue Vitriol.

Proceed as above; and for the second dip add—
12 lbs. Blue Vitriol,
12 lbs. Soda-ash.
And proceed in all respects as above.

Shake up the cotton loosely between the two dips, as well as before entering it into the tub for the first time. This is the best black that can be dyed by the two-dips method.

Slates, or the Minor Shades of Black.

It is in these minor colors, more than any other, that experience and judgment in the dyer are absolutely indispensable. The variety in tone of numerous fancy shades being so great, no recipe can be given to color any particular pattern. The numerous shades are principally due to the diminution of the original color to which they belong.

Thus, all the slates point directly to the black, and the drabs to the olive, and the fawns to the brown, as the source from which they separately proceed. They represent three separate scales of color, divided into as many parts as there are distinct varieties in their appearance, each variety representing one degree, or quantity of color, more or less, than the one preceding or following it, in an apparently graduating scale. We shall, therefore, only give recipes for such particular shades as we have colored, which range from the darkest slate to lead.

Dark Slate.

Cotton, 200 lbs.

36 lbs. Chip Logwood,
13 lbs. Sumac.

After boiling these one and a half hours, enter the cotton; pole up well; boil one and a half hours. Let the cotton lie in the liquor as long as you can before saddening; then use in saddening,

4 lbs. Copperas.

Dissolve the copperas in some convenient vessel (half a barrel) before throwing it upon the cotton; pole up well. Do not boil after saddening it, but leave in the cotton as long as possible.

Slate.

Cotton, 225 lbs.

12 lbs. Extract Logwood,
10 lbs. Sumac.

Proceed as with No. 22; then sadden with

6 lbs. Copperas.

Boil one-half hour. Leave in as long as possible.

Another Dark Slate.

Cotton, 200 lbs.

40 lbs. Cutch,
20 lbs. Chip Fustic,
8 lbs. Blue Vitriol,
40 lbs. Chip Logwood.

Boil one and a half hours; then enter the cotton at a boil, pole well, and boil one hour, and let it remain in the liquor two hours; fish out, and add to the liquor,

40 lbs. Chip Logwood,
4 lbs. Soda-ash.

Boil these one and a half hours; then add

4 lbs. Blue Vitriol.

Re-enter the cotton as usual. Let it remain in all night.

LIGHT SLATE.

Cotton, 200 lbs.

20 lbs. Cutch,
20 lbs. Chip Fustic,
40 lbs. Chip Logwood.

Boil these materials one hour; then add—

5 lbs. Soda-ash,
7 lbs. Blue Vitriol.

Enter the cotton, boil one hour, and leave in all night.

LEAD.

Cotton, 175 lbs.

7 lbs. Cutch,
$1\frac{1}{2}$ lbs. Extract of Logwood.

After these are dissolved, add—

2 lbs. Blue Vitriol,
4 lbs. Copperas.

Rake up the tub, and enter the cotton; pole up well, and boil one hour; leave the cotton in this all night.

Any variations from these shades can be obtained, by different proportions and amount of the several materials mentioned in the recipes.

If these shades are required to incline more to the black, use more logwood; if more to the olive shade, use more fustic; if more to the brown, use more of the cutch. But as stated at the beginning of these recipes, the dyer will have to depend upon his own skill and knowledge in these matters.

Brown.

This color, when it is dyed by the best methods, will continually grow richer and deeper, the longer it is exposed to the atmosphere, and the process of manufacturing produces beneficial effects upon, and for these reasons it is one of the best colors that can be made upon cotton to mix with wool. There are a variety of shades of brown, consisting chiefly of three separate or distinct peculiarities: the dark brown, yellow brown, and red brown. The other varieties are obtained by a variation in the quantity of the material used to color brown.

Brown.

Cotton, 180 lbs.

100 lbs. Cutch,
65 lbs. Extract of Logwood,
10 lbs. Sumac,
6 lbs. Blue Vitriol.

Enter the cotton at a boil, pole up well, boil one hour, and leave it in the solution all night; then fish it out, and save the liquor for further use; extract the cotton, or drain it well. In another tub of clear water, dissolve six pounds chrome; enter the cotton (after being well shook out) at a boiling heat; pole up well; leave it in for two hours; draw off; air well. Drain it, or what is better, extract it.

For the next two hundred pounds, use a quarter less material in the first bath, but always have a fresh bath for the second dip, using the same amount of chrome, and proceed in all respects as for the first 180 lbs. cotton.

Brown.

Cotton, 225 lbs.

75 lbs. Cutch,
20 lbs. Sumac,
5 lbs. Blue Vitriol.

Enter the cotton at a boil, and boil until the cotton is saturated. Let it stay in the tub all night. Take it out in the morning, and let it drain well or else extract it. Shake it up well; then dissolve in a fresh bath—

6 lbs. Chrome,
5 lbs. Blue Vitriol.

Enter the cotton at a boiling heat, boil half an hour; leave it in two or three hours; air well before washing it off.

For the next 225 lbs. cotton, add to the first bath—

50 lbs. Cutch,
15 lbs. Sumac,
2 lbs. Blue Vitriol.

Proceed as above.

Second Dip.

6 lbs. Chrome,
5 lbs. Blue Vitriol.

For every succeeding 225 lbs., use the same amount of dyestuffs. But the second dip or mordant bath must be drawn off each time.

Another Brown.

A very good and cheap one.
Cotton, 150 lbs.

40 lbs. Cutch,
10 lbs. Extract of Logwood,
5 lbs. Extract of Fustic,
6 lbs. Blue Vitriol.

Enter the cotton, and boil one hour. Let it remain in the tub all night. In the morning, fish it out, and let it drain well. Add to the liquor—

30 lbs. Cutch,
7 lbs. Blue Vitriol.

Re-enter the cotton, boil gently half an hour, and let it remain as long as convenient; fish out and wash off the cotton.

Second Dyeing in the same liquor.

Cotton, 150 lbs.

35 lbs. Cutch,
5 lbs. Extract of Logwood,
3 lbs. Blue Vitriol.

Enter the cotton, and boil one hour. Let it remain in as long as possible (four or five hours); fish out, and drain it as long as time will allow.

Add to the same liquor—

25 lbs. Cutch,
8 lbs. Blue Vitriol.

Re-enter the cotton; boil half an hour; let it stay in all night. By this method we can color one hundred and fifty pounds of cotton per day, in the same tub, by always entering for the second dip late in the afternoon, which will give the cotton a chance to imbibe the color more fully by lying in the solution all night.

Brown.

Tannin Process.

Cotton, 200 lbs.

50 lbs. Cutch,
8 lbs. Blue Vitriol.

Enter cotton at a boiling heat; pole up well; let it steep over night; next morning fish it out; drain or extract it then in a fresh bath. Dissolve as

Mordant.

Chrome, 6 lbs.—

Enter the cotton at a boil heat; pole up well; leave in two or three hours; draw of; take out the cotton and extract. In a fresh bath, boil up for one and a half hours.

Dyeing.

30 lbs. Hypernic,
20 lbs. Chip Logwood; then add —
10 lbs. Alum.

Enter the cotton, and boil one hour; draw off; then wash the cotton. The first liquor can be saved, and for the next two hundred pounds of cotton, add to it —

40 lbs. Cutch,
6 lbs. Blue Vitriol.

The second and third baths must be drawn off.

Another Brown, Lighter than the Last.

Cotton, 200 lbs.

The tannin and mordant baths are the same as for the last brown. The dyeing-bath is made up with —

40 lbs. Chip Fustic,
40 lbs. Chip Hypernic,
10 lbs. Alum.

Proceed in all respects as for the preceding brown.

Brown, Lighter than either of the Above.

Cotton, 125 lbs.

45 lbs. Cutch,
30 lbs. Camwood.

Boil the cutch and camwood two hours; then enter the cotton, and boil half an hour; then throw on six pounds of blue vitriol; pole up well, and boil half an hour longer; draw off the tub, take out the cotton and extract it. In a fresh bath dissolve,

7 lbs. Chrome,
5 lbs. Blue Vitriol.

Re-enter the cotton at a boiling heat; pole up well; leave it in for one or two hours; then draw off; wash off the cotton.

Nos. 13, 14, and 15 are perfectly fast colors, and will resist all the fulling and scouring that any color will on wool.

Dark Brown.

200 lbs. Cotton.

First bath. 40 lbs. Cutch,
15 lbs Camwood,
3 lbs. Blue Vitriol.

Boil the cutch and camwood one hour; then add the blue vitriol; enter the cotton and boil one hour; let it remain in the solution three or four hours; then fish it out, and keep the solution for further use.

Second bath. 12 lbs. Chrome.

Boil the cotton for twelve or fifteen minutes; leave it in for a few hours; then draw off; take out the cotton and rinse it off.

For the second two hundred pounds of cotton, add to the first bath,

30 lbs. Cutch,
10 lbs. Camwood, and
2 lbs. Blue Vitriol,

and proceed as for first two hundred pounds. The second, or chrome bath, will be the same as for the first.

Dark Brown (the darkest).

Cotton, 200 lbs.

50 lbs. Cutch,
25 lbs. Extract Logwood,
4 lbs. Blue Vitriol.

Proceed as for the above.

Second bath. 12 lbs. Chrome.

Proceed as above, but extract the cotton from this bath.

Third bath. 20 lbs. Chip Fustic,
25 lbs. Camwood.

Boil these for one and a half hours; enter cotton, and boil one hour; draw off, and wash the cotton.

For the next two hundred pounds, add

40 lbs. Cutch,
20 lbs. Extract Logwood, and
3 lbs. Blue Vitriol,

and proceed as before. The other two baths will have to be made fresh every time. These two are the darkest browns that we ever colored.

Minor Shades of Browns — Red-Fawn.

Cotton, 230 lbs.

10 lbs. Cutch,
10 lbs. Camwood.

Boil these drugs for one hour; then enter the cotton and boil one hour longer; then dissolve in a barrel of the dyeing liquor—

3 lbs. Blue Vitriol.

Throw in this solution and pole the cotton well for twenty minutes. Let it remain in the liquor all night, then draw off.

Salmon-Fawn.

Cotton, 180 lbs.

25 lbs. Cutch,
5 lbs. Extract of Fustic,
5 lbs. Extract of Logwood,
4 lbs. Blue Vitriol.

Proceed as for the last recipe, only let it stay in the liquor all night before finishing it off; then

Finish in a fresh bath with—

6 lbs. Bichromate of Potash.

Enter the cotton at a boiling heat; leave it in two or three hours; take out and wash it off. You can keep the first liquor for further use by adding two-thirds of each article for every 180 lbs. of cotton, and finish off as for the first 180 lbs.

Another Fawn.

Cotton, 180 lbs.

25 lbs. Cutch,
5 lbs. Blue Vitriol.

Enter the cotton and boil one hour; let it stay in all night; in the morning take out and drain well; then

Finish in a fresh bath with—

5 lbs. Chrome.

Enter at a boiling heat; let it remain in two hours; then take out and wash the cotton.

Crab-Fawn.

Cotton, 200 lbs.

10 lbs. Sumac,
35 lbs. Extract of Logwood,
50 lbs. Cutch,
2 lbs. Blue Vitriol.

Boil the cotton one hour; leave it in all night; next day finish off in a fresh bath of—

4 lbs. Chrome,
4 lbs. Blue Vitriol.

Boil the cotton fifteen minutes; draw off and wash the cotton. Keep the first liquor, and for the next 200 lbs. of cotton add to the first bath—

8 lbs. Sumac,
25 lbs. Extract of Logwood,
35 lbs. Cutch,
2 lbs. Blue Vitriol.

Proceed as above, and in the finishing bath use the same amount of chrome and blue vitriol.

Sage Color.

Cotton, 175 lbs.

8 lbs. Chrome,
8 lbs. Blue Vitriol.

Enter the cotton and boil one hour; let it remain in the liquor overnight. Drain or extract the water out of the conton before entering it into the finishing solution.

Finish off with—

12 lbs. Extract of Logwood,
25 lbs. Extract of Fustic.

After these materials are dissolved, enter the cotton and boil one hour; leave it in as long as convenient.

Claret.

Cotton, 100 lbs.

40 lbs. Sumac.

Boil out the sumac; then enter the cotton and boil long enough to saturate the cotton, and let it remain in this solution all night; draw off; drain or extract the cotton; then, in a fresh bath of cold water, add enough muriate of tin to make it indicate 2° by Twaddle's hydrometer; enter the cotton, pole it up well, and let it remain in for two or three hours; take it out and wash it off well.

Then finish in a bath with fifty lbs. chip logwood. After boiling the logwood one and a half hours, take out the bags and add four lbs. alum; then enter the cotton and boil for one hour; leave it in an hour or two, then draw off.

Another Claret.

Cotton, 100 lbs.

Work the cotton as above in—

25 lbs. Cutch.

Then in the muriate of tin bath as above; and
Finish off with—

75 lbs. Chip Logwood,
4 lbs. Alum.

Proceed in all respects as for the last recipe. These two colors are *perfectly fast*, and are very bright and clear. These recipes were obtained from Richard Sager of Rochdale, Eng.

Olives.

In coloring the different shades of olive we incline them from the true olive towards the brown shade, by using more cutch, and towards the green shade, by using more fustic or sumac; but we must bear in mind that the fustic will rise in the after-working, giving out its yellow when fulled. The olives rank next to blacks for depth and intensity of hue, and requires a great amount of dyestuffs to color it upon cotton.

Green-Olive.

Cotton, 200 lbs.

50 lbs. Cutch,
60 lbs. Extract Fustic.

Leave the cotton in the tub all night; next morning fish it out and extract it, and then add to the liquor

20 lbs. Extract Logwood,
10 lbs. Blue Vitriol,
10 lbs. Soda-ash.

After the liquor has ceased foaming, enter the cotton (after having it shook up well) quickly, and pole up well. Boil half an hour, and let it remain in the liquor as long as convenient. By commencing in the afternoon with the first dip, we can color two hundred pounds per day. For the next two hundred pounds of cotton, reduce the materials in each dip one-fifth, and proceed as before.

Yellow-Olive.

Cotton, 200 lbs. First dip.

25 lbs. Cutch,
10 lbs. Sumac,
4 lbs. Blue Vitriol.

Enter cotton at a boil, and pole up well. Boil one hour, and leave in as long as possible (two or three hours at least). Extract the cotton.

Fresh bath, or second dip.

5 lbs. Chrome,
3 lbs. Blue Vitriol.

Enter cotton at a boiling heat, and pole up well. Let it remain in this solution from one-half to one hour, and draw off. Extract the cotton.

Third dip.

15 lbs. Extract Fustic,
3 lbs. Extract Logwood,
2 lbs. Blue Vitriol.

Enter the cotton, boil one hour, and leave it in as long as convenient. Shake up the cotton before entering it from one tub to the other.

For the next two hundred pounds of cotton add to the first tub

20 lbs. Cutch,
8 lbs. Sumac,
3 lbs. Blue Vitriol.

Second dip or tub, proceed as above, as this solution will always have to be thrown away.

Third dip. Add to the third tub or finish liquor,

10 lbs. Extract Fustic,
2 lbs. Extract Logwood,
1 lb. Blue Vitriol.

Proceed in all these operations as for the first two hundred pounds.

Olive.

Cotton, 250 lbs.

Tannin process, or first dip.

35 lbs. Cutch,
18 lbs. Sumac,
5 lbs. Blue Vitriol.

Enter and boil one hour. Leave in all night. Heave out and save the liquor for further use.

Mordant Process.

8 lbs. Chrome,
5 lbs. Blue Vitriol.

Enter the cotton at a boiling heat, pole up well, and leave in two or three hours. Draw off, and extract the cotton.

Dyeing Process.

15 lbs. Extract Logwood,
30 lbs. Extract Fustic,
8 lbs. Blue Vitriol.

Enter cotton at a boiling heat, pole up well, and let the cotton remain in this solution as long as possible. If a greener shade is wanted, use more blue vitriol in the dyeing process. The third tub, or the *dyeing process* liquor can be saved for a second two hundred and fifty pounds of cotton, by adding to it two-thirds of the materials; but for the second two hundred and fifty pounds of cotton you must add to the first tub or *tannin process*

25 lbs. Cutch,
12 lbs. Sumac,
3 lbs. Blue Vitriol.

Proceed as for the first two hundred and fifty pounds. This is the best, although the most laborious and expensive; but it can be relied upon at all times as being permanent.

Another Olive.

Cotton, 225 lbs.

10 lbs. Sumac,
16 lbs. Extract Fustic,
8 lbs. Extract Logwood,
5 lbs. Blue Vitriol.

Enter the cotton as before enjoined, and leave in all night. Take out the cotton and air it well, then shake it up well. Add to the liquor,

2 lbs. Extract Logwood,
4 lbs. Soda-ash,
5 lbs. Blue Vitriol.

Enter cotton, pole up well, and boil twenty minutes. Let it remain in a few hours.

Second dyeing in same liquor. Same amount of cotton.

8 lbs. Sumac,
12 lbs. Extract Fustic,
6 lbs. Extract Logwood,
3 lbs. Blue Vitriol.

Proceed as above, and then add

2 lbs. Extract Logwood,
2 lbs. Soda-ash,
3 lbs. Blue Vitriol.

Proceed in all respects as for the first tubful.

Drabs, or Minor Shades of Olives.—Stone Drab.

Cotton, 225 lbs.

25 lbs. Cutch,
4 lbs. Extract Logwood,
3 lbs. Blue Vitriol.

Boil the cotton one hour; and then sadden with

4 lbs. Copperas.

Proceed the same as for Dark Slate. Let the cotton remain in all night.

Dark Drab.

Cotton, 210 lbs.

40 lbs. Cutch,
6 lbs. Extract Logwood,
4 lbs. Extract Fustic,
5 lbs. Blue Vitriol.

Proceed as for Dark Slate; then sadden with
4 lbs. Copperas.
Leave in all night.

Red–Drab.

Cotton, 250 lbs.

35 lbs. Cutch,
18 lbs. Sumac,
5 lbs. Blue Vitriol.

Boil the cotton one hour; leave in all night. Next morning fish out the cotton, and save the liquor for another two hundred and fifty pounds of cotton, by adding two-thirds of the above amount of materials.

In a fresh bath, dissolve
8 lbs. Chrome,
5 lbs. Blue Vitriol.

Enter the cotton; pole it up well; do not boil it. Let the cotton remain in this solution two or three hours; draw off, take out the cotton, and wash it off.

Silver–Drab.

Cotton, 225 lbs.

10 lbs. Cutch,
1 lb. Extract Logwood.

When these are all dissolved, add

3 lbs. Copperas,
1 lb. Blue Vitriol.

After they are dissolved enter the cotton, and boil one hour. Leave in all night.

Satin, or Pearl Drab.

Cotton, 200 lbs.

4 lbs. Chip Logwood,
5 lbs. Camwood.

Boil these drugs one hour; then enter the cotton, and boil it one hour. Let the cotton remain in two hours; then draw off, and fill up the tub again with cold water, and let it remain in this all night.

All these colors will rise by age, and in the fulling and scouring operation.

This will be of a very light-blue drab, after it is fulled and scoured.

Another Red-Drab.

Cotton, 200 lbs.

35 lbs. Cutch,
6 lbs. Blue Vitriol,
2 lbs. Copperas.

After these are all dissolved, enter the cotton; boil one hour, and leave in all night.

Yellow.

This color is seldom called for, its principal use being for mixtures, and that in very small quantities. The color being dyed with fustic, is very cheap, and is sufficiently permanent and bright for almost all purposes. It can be colored with quercitron bark or with its extract, and with various other

yellow coloring substances. It might be dyed by the chromate of lead process; but if produced by this process, it would not resist the fulling and scouring. Fustic being the cheapest dye, and sufficiently bright and durable to answer the purpose of this branch of dyeing, it will probably be the only article that will be generally employed for coloring raw cotton or cotton-waste.

Yellow.

Cotton, 210 lbs.

25 lbs. Extract Fustic,
10 lbs. Blue Vitriol.

Enter the cotton, and boil one and a half hours; leave it in all night. In the morning, fish out the cotton, and wash off and dry. Save this liquor, as you can color in it for an indefinite length of time.

For the second dyeing, same amount of cotton, add to the above liquor,

18 lbs. Extract Fustic,
7 lbs. Blue Vitriol.

Proceed in every respect as for the first dyeing.

This color is perfectly fast. We can take another course in dyeing by this process, by dividing it into two operations; thus,—

17 lbs. Extract of Fustic,
6 lbs. Blue Vitriol.

Enter the cotton and boil one and a half hours; let it remain in the solution another hour; then fish out the cotton and strengthen up the solution with the rest of the materials; thus,—

8 lbs. Extract of Fustic,
4 lbs. Blue Vitriol.

Re-enter the cotton and boil one hour, and leave it in the solution overnight.

This process occupies more time, and requires more labor, than to color off at one dip; yet it is the best method, as the color is richer than when produced at one operation.

You can *spring* the fustic with about two pounds of soda as with the fustic, being careful when you add the blue vitriol afterwards.

Another Method.

Cotton, 200 lbs.

Prepare with—

5 lbs. Chrome,
5 lbs. Blue Vitriol,
8 lbs. Alum.

Enter the cotton at a boil; pole up well and boil one and a half hours; leave it in the solution all night. In the morning take it out and extract it thoroughly; shake it up well; then enter it into the finishing bath.

Finish with—

120 lbs. Chip Fustic.

Bag the fustic and boil it one and three-fourths hours; take out the bags and add five lbs. blue vitriol. Enter the cotton, pole up well, and boil one hour. Let it remain in the solution all night.

Blue.

The deepest and most permanent shades of blue on cotton are those that are produced by the tannin, mordanting, and dyeing processes. They will resist the fulling and scouring process remarkably well, and lose but a little of their bloom, but the bloom can be kept up by using one-sixth of the amount of logwood used in the dyeing process of hypernic-wood; that is, supposing we are using 120 lbs. of logwood to produce the shade we want, instead of that we must use 100 lbs. of logwood and 20 lbs. of hypernic-wood. The first recipe for blue is the best and most permanent one given in this work,

all the others being mere imitations, and in no case do they equal, in richness or durability, the tannin, mordanting, and dyeing process.

The other recipes answer very well for cheap goods.

Blue.

Cotton, 230 lbs.

20 lbs. Cutch,
2½ lbs. Blue Vitriol.

Boil the cotton one hour; let it remain in the solution six hours, or overnight. In a fresh bath dissolve—

8 lbs. Chrome,
8 lbs. Blue Vitriol,
4 lbs. Alum.

Shake up the cotton, enter it and boil half an hour; let it remain in the solution overnight; in the morning extract it thoroughly. Then

Finish off with—

35 lbs. Extract of Logwood (or 185 lbs. Chip Logwood),
5 lbs. Blue Vitriol.

Shake up the cotton well and enter it rapidly; pole up well; boil half an hour; then let it remain in the solution as long as it improves in color.

[We will here state that whenever the blue vitriol is to be used in the dyeing process, it should not be added until after the coloring-matters are boiled out.]

Blue (for jeans, a good one).

Cotton, 200 lbs.

Prepare with—

7 lbs. Chrome,
7 lbs. Blue Vitriol,
5 lbs. Alum.

Boil the cotton in this for one and a half hours; let it remain in the solution overnight; take it out and extract it well. Shake up the cotton, then finish off with—

100 lbs. Logwood (Chips),
10 lbs. Hypernic-wood,
2 lbs. Blue Vitriol.

After boiling the woods one and a half hours, take out the bags, and dissolve the blue vitriol, and add it to the solution. Rake up the tub, and enter the cotton smartly, and pole up quickly, and boil for half an hour; then leave it in as long as the color improves. In coloring by this recipe, the cotton must be handled quickly in getting it saturated with dyeing matters, as it is very difficult to get the cotton evenly dyed.

A Lighter Blue.

Cotton, 200 lbs.

Prepare with—

6 lbs. Chrome,
6 lbs. Blue Vitriol,
4 lbs. Alum.

Finish with—

75 lbs. Logwood (Chips),
5 lbs. Blue Vitriol.

Proceed in every respect as for Blues on page 665.

Blue.

Cotton, 200 lbs.

15 lbs. Extract of Logwood,
8 lbs. Blue Vitriol.

Enter the cotton, and boil one and a half hours; pole it up well. After remaining in as long as time will admit (two or

three hours), fish out the cotton, let it drain as long as convenient, then add to the solution—

5 lbs. Extract of Logwood,
3 lbs. Extract of Hypernic (or 15 lbs. Hypernic Chips,
7 lbs. Soda-ash,
7 lbs. Blue Vitriol.

After the ash and blue vitriol are dissolved (which must be done separately), and the liquor has ceased foaming, re-enter the cotton and boil half an hour. Let the cotton remain in the solution over night. Fish out the cotton, and save the liquor for further use. In coloring a second or more tubfuls (200 lbs.), proceed in every respect as above, only reduce the materials one-fifth for each 200 lbs. of cotton.

INDEX.

PART FIRST.

PART SECOND.

PART THIRD.

PART FOURTH.

ERRATA.

The recipe for rich, full blue, on page 541, should read,—

Prepare with—

13 lbs. Alum,
4 lbs. Oxalic Acid.

Boil cloth 1¾ hours; next, dry finish with 60 ponnds chip logwood. Boil the logwood 1½ hours; take out the bags, and cool down; then add

1 quart Scarlet Spirits,
1 pint Ammonia.

Rake up well; enter cloth, and boil 1½ hours; take out, air well, wash off.

On page 641. "To every pound of nitric acid, 40° Fahr.," should read "40° Twaddle."

200 lb Wool Dar
Blue in bat to di
chrome alum for
finish
35 lb Cudbear,
40 " Hypernic
3 " Logwood

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